# POWER

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## The Work Habit

HEADED for success into whatever status he was born, in whatever direction he turns his effort, is the man who knows how to work.

I do not refer now to manual skill or mental ability, to particular cleverness in doing a job, but to the faculty of buckling down to it and seeing it through.

Anyone can work when the thing that is being done or made is something in which he is particularly interested, something the completion of which will be a pleasure and a profit to himself.

But the ability to overcome lassitude and inertia, to pull away from the diversion that is calling, to tackle the thing that ought to be done and to stick to it with bulldog tenacity until it is accomplished, is the quality that makes a man useful and wins him a livelihood and more.

Some men will use more ingenuity and real effort in getting rid of a job than would twice do it. Others are always looking for a chance to be useful.

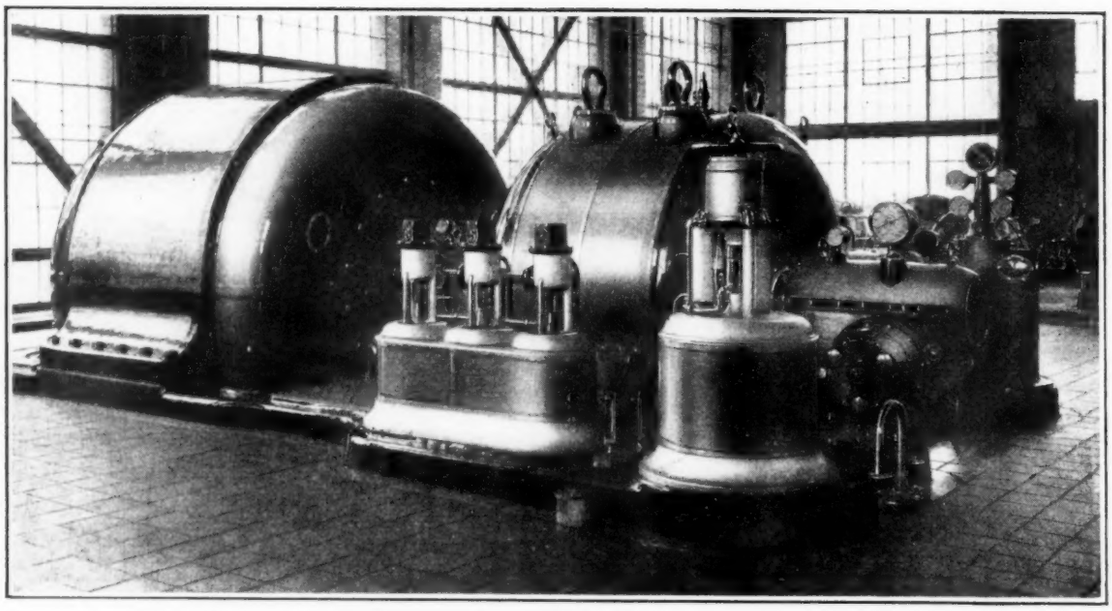
It may be true, as Mr. Duncan remarks on page 66 of the July 12 issue, that the man who ducks responsibility may hold his job the longest, but it will always be a job, a position of servitude; while the man who seeks uses for his abilities, will not only find widened opportunities but find that his abilities increase with their employment.

Every good thing is the product of labor. If you enjoy the good things of life, you have either got to make them, crook them, or have some good angel to feed them to you.

And angels are not so plenty.

Get the Work Habit.

F. R. Low



*Head—Turbine room at the Ford Iron Mountain plant*

# Ford Motor Company Designs and Builds Its Own Small Turbines

**FOR use in its various assembly plants the Ford Motor Company has designed and constructed in its own shops a number of turbine-generator units ranging in size from 75- to 5,000-kw. This article describes in detail the design of the 5,000-kw. unit and indicates the main design features of some of the smaller units.**

IN THE shops of the Ford Motor Company have been built straight-condensing, bleeder and back-pressure turbines of 5,000-kw. capacity. Of these the bleeder-type turbines will be described. In general its design is similar to the 45,000-kw. Ford unit described in the Jan. 20, 1925, issue of *Power*. The turbine rotates at 1,800 r.p.m., receives steam at 225 lb. pressure, 200 deg. F. superheat, and exhausts to a vacuum of 28.5 in. Hg. It has one double-row impulse wheel and nine rateau stages, all stages having the same pitch diameter.

The heat drop to the bleeder connection is utilized in a double-row impulse wheel and in two rateau stages. Steam is bled at a pressure of 10 lb., while the steam remaining in the turbine expands to condenser pressure through 7-rateau stages. A cross-section of the turbine is shown in Fig. 1. The high-pressure cylinder consists of as many rings as there are stages. Each ring is cast integral with the diaphragm, and at its outer edge is provided a flange for bolting to adjoining similar rings. A key of rectangular section centralizes the joints of two adjacent rings. Special care is taken of the drainage of the turbine cylinder, and each of the stages outside of the low-pressure housing has its own drain valve that can be operated from the main stop-valve stand. The low-pressure part consists of an outer shell with the exhaust connection cast in one, and three internal rings similar to the high-pressure stage rings, each one forming a low-pressure stage. The exhaust flange bolts directly to the condenser inlet flange without any flexible expansion joint. The weight of the three-pass surface condenser containing 9,000 sq.ft. of cooling surface, is carried by 28 springs.

The turbine and generator rest on a bedplate consisting of four parts solidly bolted together. Four feet, two cast with the exhaust housing and two bolted to the high-pressure cylinder, keep the turbine housing in place. To take care of expansion, the exhaust-housing feet are permitted to move laterally, while the high-pressure cylinder feet move in both directions, laterally and axially. The exhaust housing is kept central by a block located under the middle pedestal and is permitted only up and down movement between guides fastened to the bedplate. The front pedestal is bolted to the high-pressure cylinder by means of a semicircular support ring and can move only axially. The turbine blades are machined in one with distance piece and cover shroud. The long blades receive one or two parti-

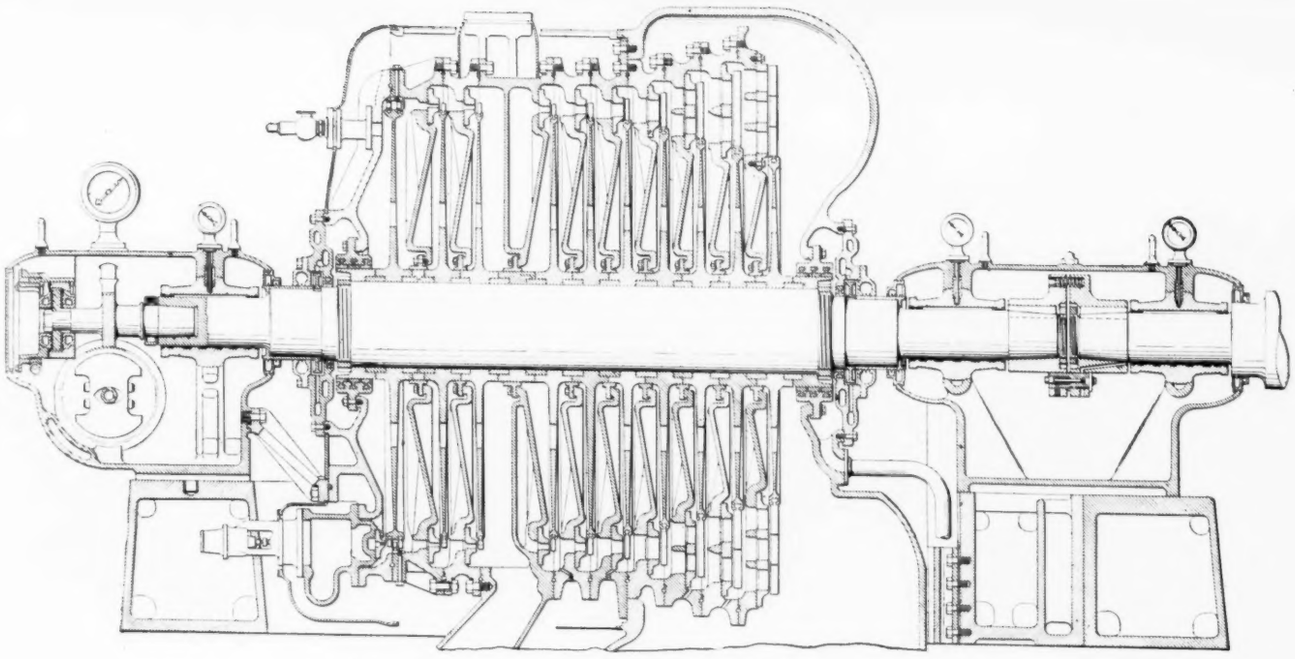


*Fig. 1—Section through 5,000-kw. bleeder turbine*

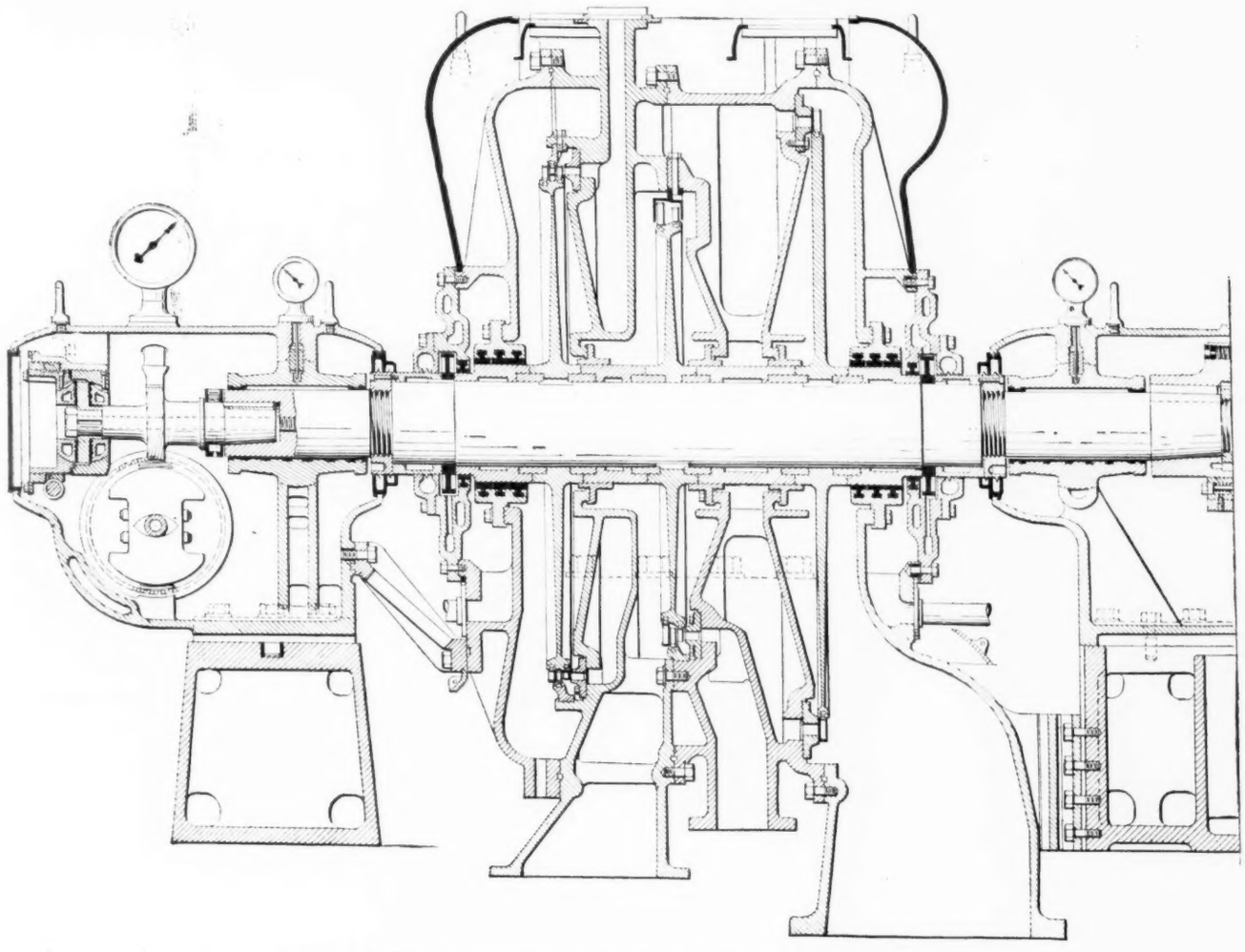


*Fig. 2—Section through 5,000-kw. bleeder-back-pressure turbine*

tions (ribs). Adjoining blades therefore touch each other at root, partitions and cover shroud, forming several steam channels. This construction makes the whole assembly of blades rigid and gives great resistance to vibration. The blades of the eighth and ninth wheels have one partition, and those of the last wheel have two partitions. Fig. 3 shows a last-stage blade which has a free length of 14½ in. The foot of the blade, in the form of a tee, fits into a slot of similar section. The roots of the heavy blades have two projections, one on each side, which overlap two shoulders on the wheel, in this way preventing the rim of the wheel from splitting open. To prevent shaft leakage steam and water glands are provided at the high- and low-pressure ends of the shaft. If vacuum is desired when the turbine is either standing still or rotating at low speed, saturated steam is introduced to the steam glands (the water glands do not function at low speed). The internal labyrinth glands between stages are bolted to the diaphragms. The torque of the turbine is transmitted to the generator through a coupling capable of axial movement. Four of the bolts have springs to locate the generator rotor between small limits. The pins and bushings of the coupling are lubricated from one of the adjacent bearings.

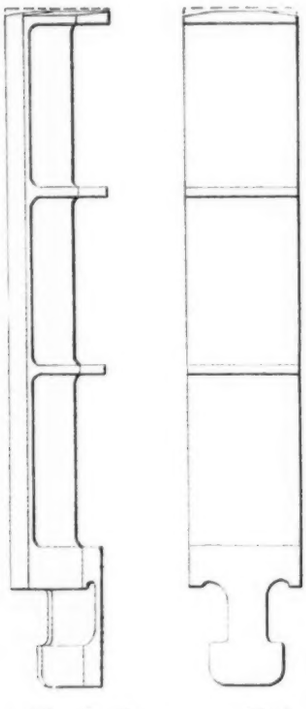


*Fig. 3—Last-stage blade*

The bearings have spherical seats and their temperature is indicated at all times by double-faced pyrometers. Axial thrust, which in the case of impulse turbines is small, is taken by a single thrust plate rotating between two spherically seated thrust rings. These thrust rings are hollow, and the lubricating oil flowing through them cools the babbitted pressure faces efficiently. The thrust-bearing housing can be adjusted axially by means of a worm drive.

### Regulation of the 5,000-Kw. Turbine

The steam piping, strainer and main-stop valve are located under the turbine-room floor. The turbine housing is protected against piping strain by the long bends shown in the end view, Fig. 4. In each of the two steam chests, one on each side of the front pedestal, are two regulating valves—four altogether. These valves and the first-stage nozzle blocks are in the lower half of the cylinder. In the upper half the double-row velocity wheel is inclosed on three sides by a cover that reduces windage losses.

One of the regulating valves is shown in Fig. 5. The governor acts on this valve without any linkage whatsoever, changing only the pressure in the oil line to the valve, as required by changes in load. The oil piston of the valve is kept in equilibrium by oil pressure on one side and by springs on the other side. The springs are adjusted to different tensions so the valves open gradually one after the other with increasing load.

A plunger fastened to the governor sleeve, and therefore moving with it, partly uncovers two slots in a stationary sleeve, through which more or less oil escapes to the sump, thus varying the oil pressure to the regulating valves. On the face of the plunger, rotating with the governor, is a shoulder which, changing the opening of the slot periodically, oscillates the oil pressure, and therefore also the regulating valve, thus preventing the valve from sticking. The speed of the turbine may be changed by moving the sleeve surrounding the pilot valve.

A triple-gear oil pump is fastened directly to the governor shaft and takes oil from an oil tank in the bedplate. From the pump the high-pressure oil for regulation flows directly to the pilot valve of the governor, while the lubricating oil, reduced in pressure, is passed through an oil cooler located in the bedplate and then to the bearings. An auxiliarly oil pump in the basement delivers oil to the bearings when the turbine is started up.

A number of safety devices are provided to prevent overspeeding. In the front pedestal an automatic-stop governor operating a three-way oil valve releases the oil pressure and at the same time closes all the regulating valves and main stop valve. This three-way oil valve can also be operated by a push knob on the front pedestal.

In the stand of the main stop valve is another three-way valve operated by a hand lever which releases the oil pressure for the purpose already described. A piston

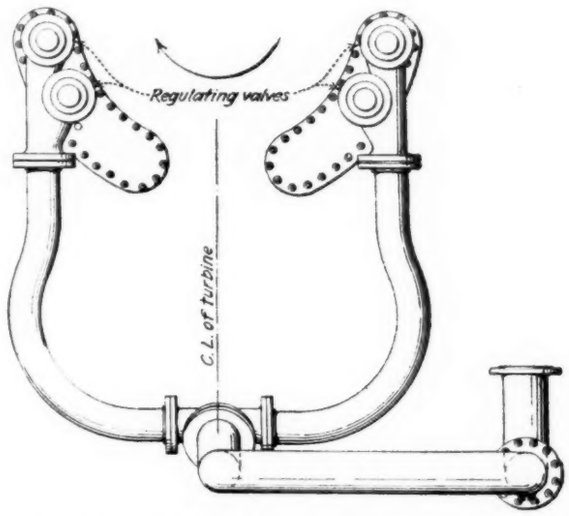



*Fig. 4—Front elevation showing arrangement of piping and regulating valves*

under oil pressure holds in place a trip key that disengages a trip spindle as soon as oil pressure in the whole system drops below a certain point, thus protecting the turbine against oil failure. Steam is bled from the third stage through two constant-pressure regulating valves, one on each side of the turbine. Should it be desired to operate the turbine as a straight condensing unit, a gate valve placed in the bleeder line is closed and the bleeder valve then screwed up and kept wide open by a hand-wheel. A check valve in the bleeder pipe prevents any steam flowing back into the turbine.

The bleeder-back-pressure turbine of 5,000 kw., 1,800 r.p.m., is designed for the same steam conditions as the bleeder turbine just described. As shown in Fig. 2, it has only three wheels of different diameters. Steam enters the turbine at the bottom in the center and flows through two double-row impulse wheels toward the front pedestal. Its direction is then reversed, being guided

through an outer shell around the two double-row wheels to the last rateau stage and exhausts against a back pressure of 10 lb. The bleeder connection is between the two double-row impulse wheels. This arrangement has the advantage that the steam and water glands have only to seal against steam of low pressure.

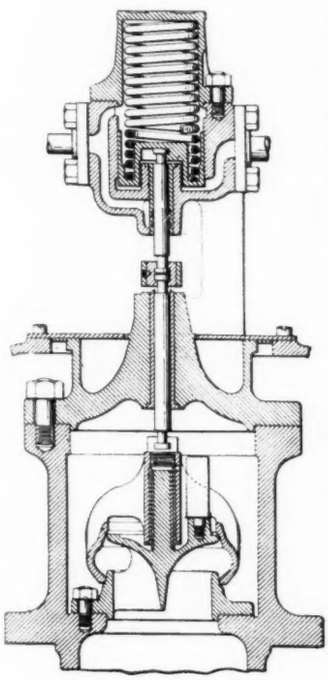


*Fig. 5—Oil-operated regulating valve*

The steam from the strainer and main stop valve passes through two steam chests, one on each side of the turbine cylinder. These separately cast steam chests, each housing three regulating valves, are connected by pipe bends to the turbine cylinder.

Of the smaller turbines built in the Ford shops are units of 75, 450 and 750 kw., a 150-hp. unit driving a circulating pump and a 15-hp. unit driving a condensate pump. Differing from the design of the larger turbines all the cylinders of these small units are split only horizontally, and the lower half is cast in one with bearing pedestals and generator-end-bell.

The 750-kw. bleeder condensing turbine built for a steam pressure of 200 lb. and 50 deg. F. superheat rotates at 3,600 r.p.m. It has two double-row impulse wheels between which is the bleeder connection. Steam is bled at a constant pressure of 18 lb. per square inch.

This unit is highly adaptable to varying conditions. It can be used bleeder condensing, straight condensing, and as a back-pressure unit with the second wheel removed and exhausting through the bleeder connections.

To obtain a better efficiency in some of the small units, simplicity is sacrificed, and in this case the turbine drives the working machine through a reduction gear.

The 450-kw. turbine operates at 6,000 r.p.m., and has one double-row impulse wheel and five single-row impulse wheels, all of the same blade pitch diameter. The housing consists of a high-pressure cylinder, which bolts to the exhaust housing; both are split horizontally, and the lower part of the exhaust housing forms one casting with bedplate and gear housing. The reduction gear is of the compact planetary type and gives a short unit, with the added advantage that the driving and the driven shaft are on the same center line.

A turbine of 150 hp. drives a circulating pump at 750 r.p.m. through a planetary gear having 10:1 reduction The turbine rotor consists of three double-row impulse wheels fastened to the shaft by conical split sleeves. Because of the small steam consumption both first and second wheels have nozzles only in the lower diaphragm and only the last wheel has the arc of admission on the whole circumference.

The smallest turbine built by the Ford Motor Co. develops 15 hp. and operates a condensate pump at 2,500 r.p.m. It has a single 3-row impulse wheel fastened to the shaft by a conical split sleeve.

## Parallel Operation of Direct-Current Generators

WHEN two or more direct-current generators are connected in parallel, the fundamental law for satisfactory operation requires that at the point where the generators are connected in parallel the voltage characteristics of the machines should be drooping. Furthermore, for equal division of load between the machines, their voltage characteristics must be alike.

Where machines are of different ratings, load division in proportion to their respective capacities can be obtained if the voltage characteristics of the machines are the same. For example, two machines *A* and *B*, of 200 and 100 kw. rating respectively, are connected in parallel. If both machines are adjusted for a no-load voltage of 220 and then a 150-kw. load is put on them, for proportional divisions of load, machine *A* should take 100 kw. and *B* 50 kw. This division of load will be obtained automatically if the voltages of the two machines are the same at these loads. If the voltage of machine *A* is higher than that of machine *B*, it will take more than its share of the load. Or, if the voltage of machine *B* has a tendency to rise above that of *A*, it will take a larger proportion of the load than it should.

Shunt generators have drooping voltage characteristics and are ideal for parallel operation. However, their voltage regulation is poor and they are not suited to most power loads. Compound generators, on account of their series winding tending to cause the voltage to rise, offer certain difficulties in parallel operation, which are generally overcome by adjusting the voltage characteristics of each machine nearly alike and by the use of an equalizer connection.

On the non-interpole compound type machine the equalizer connection is made between the armature and series-field winding. On interpole compound machines the armature, interpole and series windings should be connected in series in the order named and the equalizr connection made between the series and interpole windings. This makes the interpole winding part of the armature circuit and is therefore insured of having the same current in it that flows through the armature. If the equalizer connections were made between the armature and interpole winding, any unequal division of current in the series winding, due to the equalizer, would also occur in the interpole winding. The current in the interpole winding would not vary in proportion to the armature current, causing sparking at the brushes.

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IT IS THE PRACTICE OF MANY ENGINEERS when obtaining accumulative test samples of flue gases to collect these samples over water. Owing to the solubility of the component gases, especially carbon dioxide, in water and the variations of these solubilities with the temperature and pressure, this liquid should not be used to collect the sample if accurate results are desired. If water be used, it will absorb carbon dioxide, for example, until it becomes saturated with this gas with respect to that gas mixture. This results in a loss of some of the carbon dioxide that was in the gas. Then if a gas cleaner in carbon dioxide is collected over the same water, the water will give up carbon dioxide and increase the carbon dioxide contents of the gas. If, instead of water, a saturated solution of sodium chloride is used, these errors will be greatly reduced as the gas is much less soluble in this solution.

# Automatic Closing Elevator Doors with Interlocks

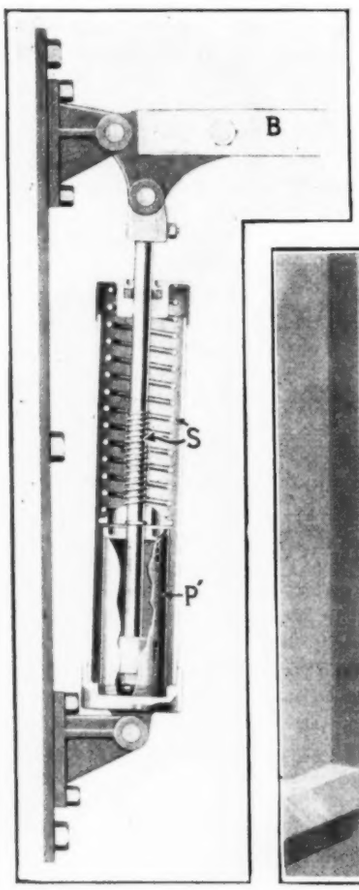
ONE of the important parts of elevator equipment is the landing doors. They must close and lock in a manner that insures safety to the passengers at the landings. When they are open, the control circuit should be open to prevent the elevator being started while the doors are open or unlocked, thus insuring the safety of the passengers getting on or off the car. From an operating point of view the landing doors should be easy to handle, so that the operator can manipulate them without undue effort. They should also be arranged so as to open and close quickly and quietly.

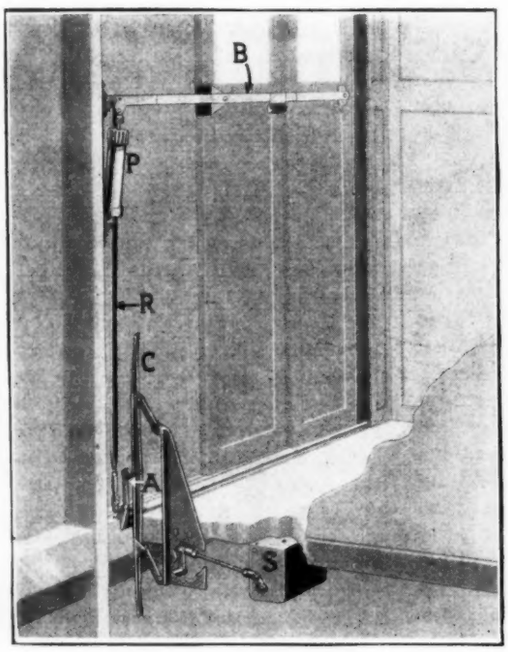
Unless the last two requirements are satisfied, good elevator schedules cannot be maintained and the service will be below par. If the doors are so hard to handle and uncertain in their operation as to fatigue the operators, they cannot justly be expected to take the same interest in rendering good service as when conditions are made easy for them to do their work.

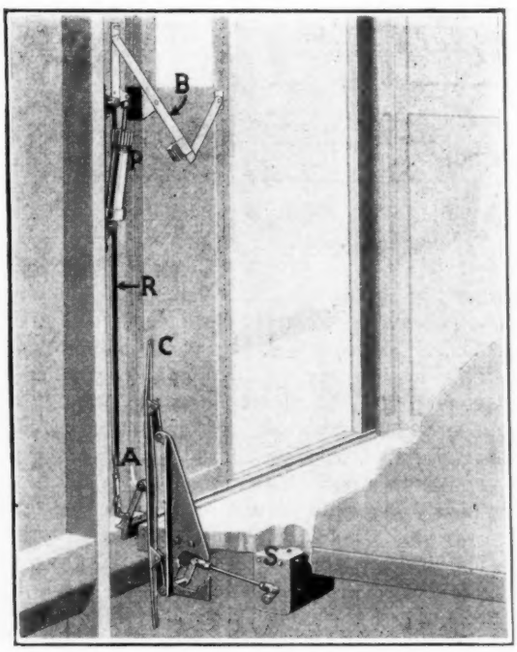
When the doors are made self-closing, the operator is relieved of a lot of work and allowed more time to give to other details of getting the passengers in and out of the car and operating the machine. If the doors are interlocked with the control so that the car cannot be started unless the doors are closed and locked, the operator can manipulate the car faster than could be done otherwise with safety.

A type of elevator door closer and interlock developed by the Shur-Loc Elevator Safety Corporation, New York City, is shown in Figs. 1 to 4. In this equipment the bar *B* of the closer is connected to both door members in the usual manner. The doors are shown in the closed position in Fig. 2 with closing bar *B* straight, and in the open position Fig. 3 with the bar bent at the joints to allow movement of the doors. As the operator pulls the doors open, a spring is compressed in cylinder *P* and provides the power for closing the doors when they are released. The doors are supported on ball-bearing hangers and therefore are easily manipulated.

A cross-section of the operating cylinder is shown in Fig. 1. At the bottom of the cylinder, which is filled with oil, is a second cylinder *P* with a piston attached to the closing bar *B*. At both ends of the inner cylinder




*Figs. 1 to 3—Section through door closer and its application to elevator landing doors*

are a series of holes or ports of graduated diameters. When the operator quickly opens the doors, bar $B$ turns in a counterclockwise direction to a vertical position. In this operation springs $S$ are compressed and as the piston in the inner cylinder rises, oil is forced out of the top ports in the cylinder and flows through the bottom ports. This action of the oil continues until the doors are near the open position, when the piston begins to cover the ports in the top end of the cylinder.

When the doors are opening, the motion of the piston is slow during the first part of the operation with an increasing rate of motion during the last part. This action also tends to promote a quick opening movement of the doors. When the operator releases the doors, they are closed by the energy stored in the compressed springs.

The ports are of graduated diameter and located so that the largest is closed first. These diameters have been selected to allow a free movement of the doors during a large part of their travel with a rapid yet smooth retardation, by the gradual covering of the ports, near the end of the closing or opening operation of the doors. Thus a cushion stop is provided for the doors at either end of travel without any adjusting screws or valves.

On this equipment, instead of a switch at each door to interlock the control, a master interlocking switch Fig. 4 is mounted on the car as shown at $S$ in Figs. 2 and 3. The movable contacts of the switch are mounted in pairs on a Bakelite insulated square shaft. Each pair of contacts breaks one side of the operating circuit, so that there are two breaks in series in each direction-switch

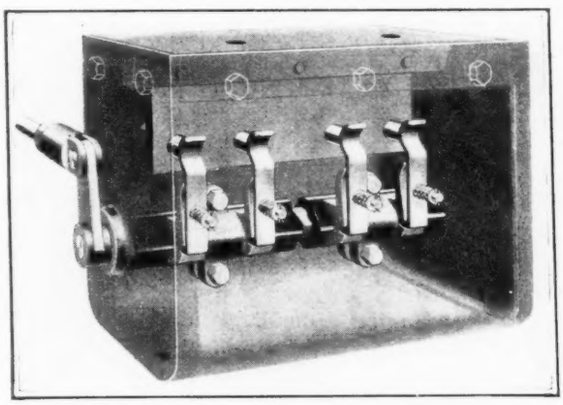


*Fig. 4—Master interlock switch*

circuit. The contacts are copper of the wiping butt type and have a capacity that will allow handling 40 amperes at 600 volts continuously.

On the car the switch $S$ is connected to a vertical bar $C$ by bell cranks and rods, as indicated in Figs. 2 and 3. A rod $R$ extends from the door closer down to the sill, where it terminates in a rocker arm $A$ having a roller in one end. When the doors are closed as in Fig. 2, the rocker arm $A$ is held in a vertical position, which allows cam $C$ to drop to the left a short distance and close the interlock switch. When the doors are opened, the rocker arm $A$ moves outward and pushes cam $C$ to the right and in doing so opens the interlock switch. Therefore as long as the doors are open the car cannot be started from the car switch. A pawl on the doors prevents them from being opened from the outside when they have reached within four inches of the closed position. An emergency switch with a break-glass cover in the car provides a means of operating the car with the doors open in emergency.

# What Do You Know?

*The answers are on page 243*

IN EACH one of former lists of "What Do You Know" questions, certain questions have covered what might, by some, be termed theory. An engineer may offer the excuse for not making 100 per cent that the particular branch of engineering theory was far afield from his particular job. The list below deals with practice alone. See how much you do know about the every-day problems of keeping a plant operating. Less than 50 per cent record will send you to the bottom of the class. It's in practical matters that men disagree, so if you fail to approve of any answer, show the editor where he is wrong. He does not claim to know it all by a long shot, and already has made three errors—can you make it a fourth?

Ques. 1—The shaft gland of a small high-speed turbine that is provided with soft braided metallic packing, occasionally produces a slight popping noise. What is the cause of this trouble?

Ques. 2—Why cannot a D slide-valve engine economically cut earlier than one-half stroke?

Ques. 3—What makes a shaft-governed engine hunt?

Ques. 4—Why is it necessary to plane down that part of boiler plates forming the laps of the circumferential joints of horizontal return-tubular boilers when the thickness of plates exceeds $\frac{9}{16}$ in.? Does this reduce the strength of the joint?

Ques. 5—How does steam become drier or superheated by the process of wiredrawing?

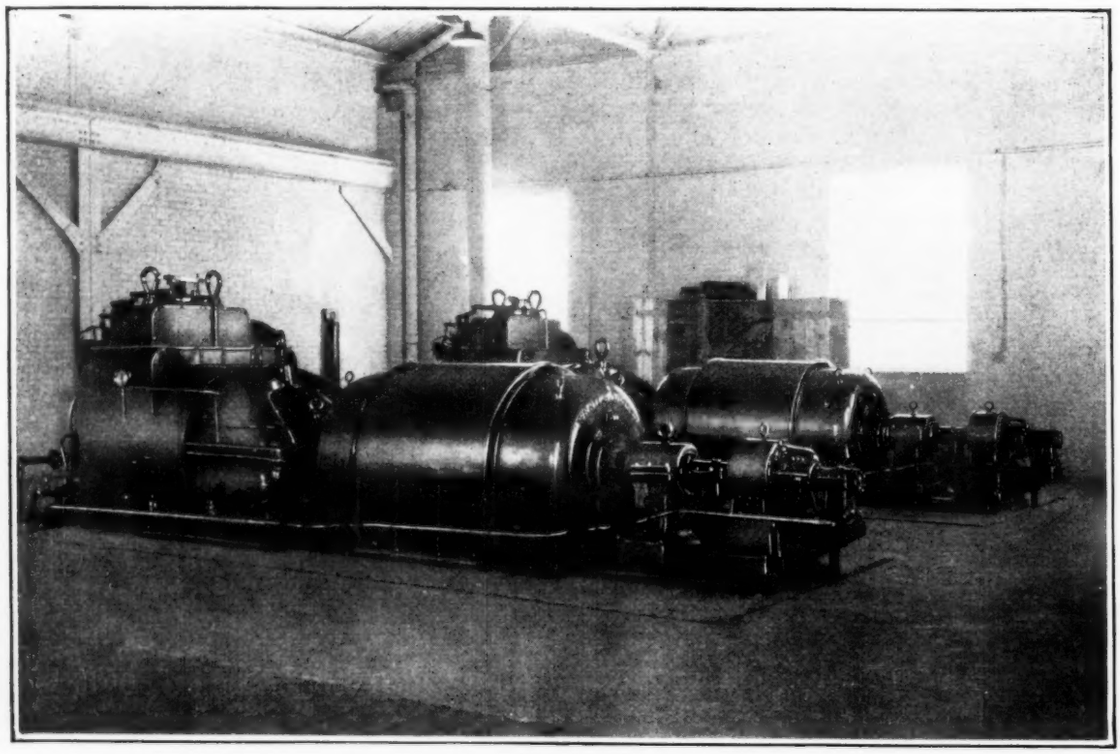
Ques. 6—What are the advantages of two-stage compression of air over single-stage compression?

Ques. 7—Is water a good or a poor conductor of electricity?

Ques. 8—How can I determine if there are foreign gases in our refrigeration system?

Ques. 9—What causes a direct steam feed pump to make short jumps of the plunger at the beginning of the stroke?

Ques. 10—What are the relative transmissive capacities of rubber and leather belting?



# Alamogordo Plant Burns Sawmill Refuse

## A New Turbine Installation of Texas-Louisiana Power Co. Utilizing Waste Products of Near-by Power Consumer

THE power plant of the Texas-Louisiana Power Co. at Alamogordo, New Mexico, and the adjoining mill of the George E. Breece Lumber Co. are operating under a mutually beneficial agreement by which the lumber company sells its refuse to the power plant for fuel and the power plant, in return, furnishes power to the mill. The two plants were erected at the same time, and both began functioning in March.

The power plant was built in close proximity to the lumber mill. The arrangement for utilizing the waste products of the latter has given the surrounding territory electric power and saved the lumber company the necessity of building its own steam plant. In addition to electric power for the motors, the power plant supplies steam for the log carriage and the kickers in the sawmill.

Hogged fuel and sawdust from the saws and planers are conveyed to the power company's storage plant. The storage bin has capacity sufficient for forty-eight hours' operation, and an outdoor storage pile is also maintained. The fuel is fed through the hopper bottoms of the storage bin to a chain conveyor, is elevated to a second chain conveyor, and is spouted into the Dutch ovens in front of the boilers. Firing is regulated by the size of the opening in the spouts.

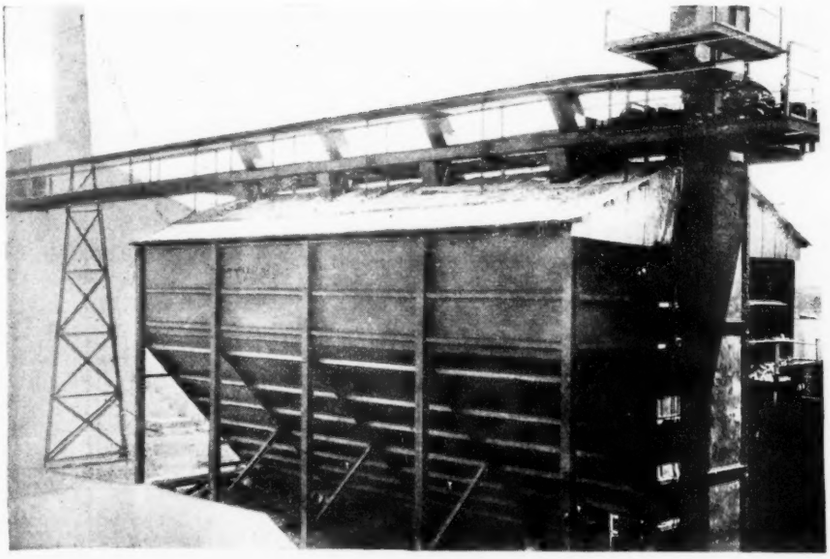
There are at present two Stirling boilers, each having 5,120 sq.ft. of heating surface. Each oven has a grate area of 100 sq.ft. The 72-in. steel stack rises to a height of 188 ft. above the ground. Provision is made for adding another boiler in the near future.

Two 1,250-kva. Westinghouse turbine-generator units have been installed. The generators supply three-phase current, 60 cycles, at 2,300 volts. The foundations are provided for an additional 2,000-kw. unit. Condensing water is cooled in a spray pond.

There are two transformer stations at the plant. One steps up to 11,000 volts for supplying outside towns; the other steps down to 440 volts for the lumber mill.

Before beginning construction of the new plant, the Texas-Louisiana Power Co. purchased the Diesel-engine-driven power plant of Alamogordo, which was municipally owned. Operation of this plant was discontinued when the new turbine installation began functioning. The new plant is now supplying not only Alamogordo, but also the towns of La Luz and Tularosa. The two outside towns have been electrified by the power company. This increase in available power is expected to bring other industries into the Tularosa Basin and to make irrigation by pumping possible over an area of 800 square miles.

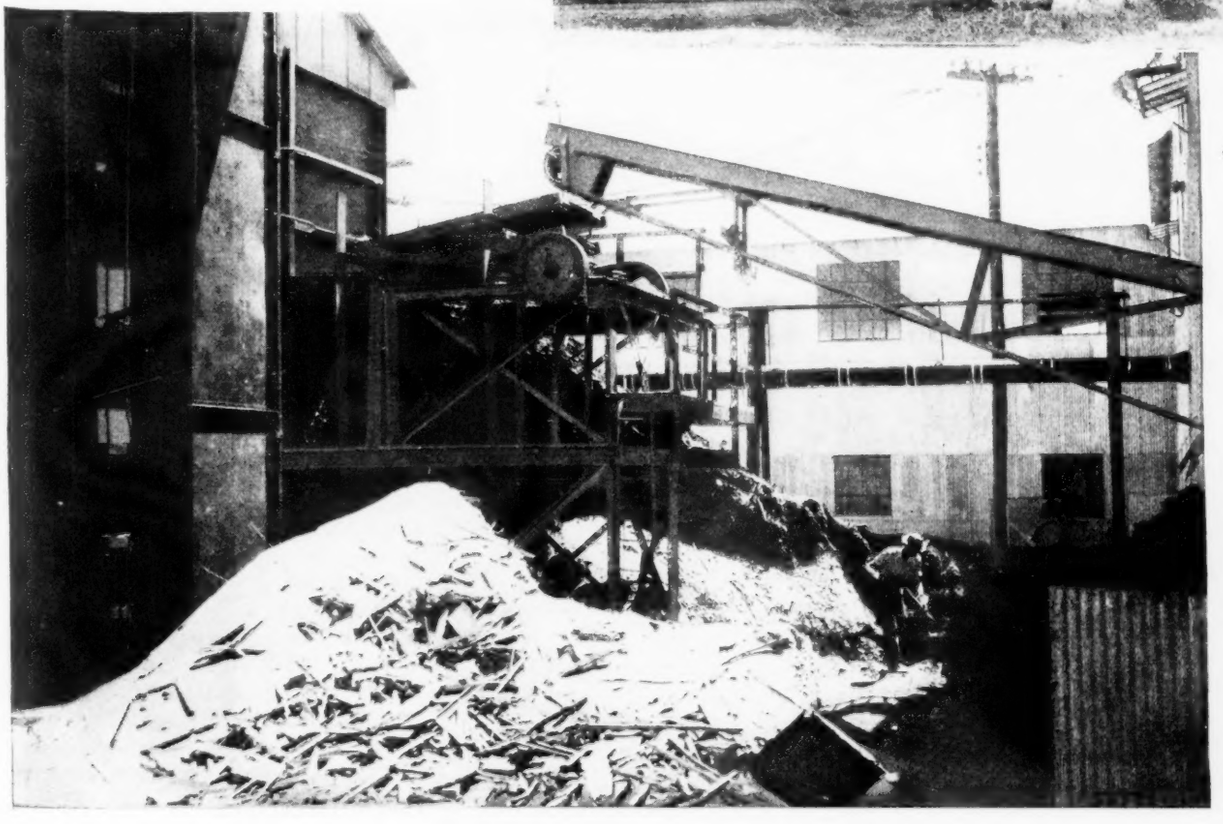
The Alamorgodo plant was constructed under the supervision of T. A. Burdick, chief engineer of the Texas-Louisiana Power Co., Fort Worth, Tex.

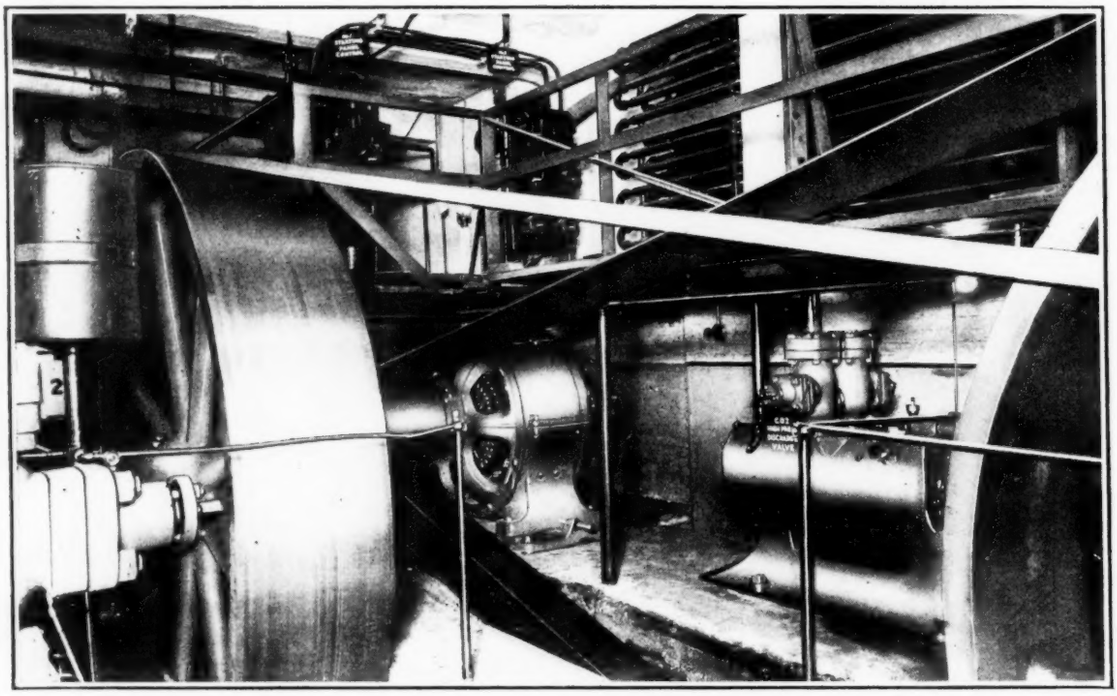


*Above—Storage bin for fuel, showing elevator and conveyor leading to spouts above Dutch ovens*

*Right—The 2,000-kw. plant of the Texas-Louisiana Power Co. with the lumber mill visible in the background*

*Below—Conveyor from sawmill to storage bin. The plant was not yet in perfect operation when this photograph was taken and men may be seen dumping wood refuse into the elevator*





# How To Operate D.C. Motors

## *At Speeds and Voltages Other Than Given on the Nameplate*

By C. B. Hathaway

*Motor Engineering, Westinghouse Electric & Manufacturing Company*

CHANGING conditions in a plant such as a change in voltage or changing from direct to alternating current, or vice versa, demands the removal of motors that are still in good condition but can no longer be used at their nameplate ratings. In the case of direct-current machines it is generally known that they can be made applicable to different purposes with only minor changes. It is the purpose of this article to give the details for these changes which, it is hoped, will be sufficiently complete so that many such machines may again be placed in service and perform some useful duty for several more years.

### Field Control of Motor's Speed

It is well known that nearly any direct-current motor, whether shunt- or compound-wound, will operate at higher than normal speed if the field is weakened, which can be accomplished readily by inserting a rheostat in series with the shunt-field circuit. The speed at which the motor runs will be inversely proportional to the flux. Owing to the saturation of the magnetic circuit the percentage decrease in flux will be less than the percentage decrease in the field current. The field current reduction necessary to give the desired speed can best be determined by experiment.

On a shunt motor the field current must be reduced to about one-third its full voltage value to obtain approximately double rated speed. This figure gives some idea of the relation between the change in field current and the change in speed. A similar reduction in the shunt-field current of a compound-wound motor will increase its speed about 50 per cent. Values of resistance and current capacity of the rheostat required for a given speed change can be determined by measuring the resistance of the shunt field with a voltmeter and ammeter. The rheostat should have twice the resistance of the shunt field in order to reduce the current to one-third its normal value. The maximum current capacity should be equal to the normal field current and the minimum capacity equal to one-third the maximum.

As an example, suppose that the shunt-field current of a motor is two amperes with a voltage of 230 across it; then, the shunt-field resistance is $230 \div 2 = 115$ ohms. Therefore, a rheostat that will approximately double the speed of the motor, if shunt wound, should have $115 \times 2 = 230$ ohms. One with a higher resistance

will be satisfactory. The maximum current capacity should be at least two amperes, and the minimum should be not less than $230 \div (115 + 230) = 0.67$ amperes.

There are certain limitations to increasing the speed of direct-current motors which, if not properly considered, may cause trouble. A shunt motor may become unstable, or unsteady in speed, with a weakened field, and may tend to run at an excessive speed; it may also flash over at the commutator. This is caused by the armature magnetomotive force crowding the flux under the main poles toward one tip of each pole. Thus, the teeth under one tip of the poles may become saturated while those under the other are not. The net result of this is a reduction in the total main flux and a rise in speed with increased armature current.

This condition is usually compensated for in machines of modern design by adding a few turns of series winding to each main pole, which strengthens the field as much as the armature distortion weakens it. Although these series turns may be adequate when the motor is operating at full field, they may not be sufficient to stabilize it at high speeds because the effect of the armature distortion is more pronounced when the field is weakened. If such a machine is encountered, it can be made to operate satisfactorily by adding two or three turns of series winding to each pole, or adding this amount to the series turns that may already be there. This can be done by adding a few turns of cable around each shunt-field coil, taking care to reverse the direction of the turns on successive poles. This winding should be connected in series with the armature.

Whether or not the series winding is connected in the correct direction can best be determined by test. If the speed is not reduced at a given load, the terminals of the series winding should be reversed. Shifting the brushes in the direction of rotation produces a compounding effect which may be sufficient to stabilize the speed. This should not be resorted to unless the commutation is normally good, and they should not be shifted to a point where sparking occurs. It is best to consider this method of correction only as a temporary relief.

### Horsepower and Torque

Since the torque of a motor is proportional to the product of the field flux and the ampere-turns on the armature, the torque decreases directly with the increase in speed. The horsepower output will be the same as with the full field. In the equation $Hp. = \frac{Torque \times r.p.m.}{5{,}250}$, the torque decreases directly with the increase in speed and there is no change in horsepower. This fact can also be understood by considering that the armature is wound with a definite size of wire which will carry only a given maximum current without overheating, and that the voltage applied to the armature has not changed. Now, the horsepower output can be expressed $Hp. = \frac{Volts \times amperes \times efficiency}{746}$, and since there has been no change in the voltage or armature current, there is no change in the horsepower. In this case the slight decrease in efficiency has been neglected.

### Operating on Low Voltage

If a motor is operated on a line whose voltage is below that of the motor rating, the speed will tend to be less due to the lower voltage across the armature. The ampere-turns on the shunt field will vary directly with the applied voltage, so the field flux will be decreased with a tendency to increase the speed. Owing to the saturation of the magnetic circuit, however, the decrease in flux is less than the decrease in the ampere-turns.

The percentage change in speed of a shunt motor will be about half the percentage change in line voltage. For example, a 230-volt shunt-wound motor running 1,150 r.p.m. will drop to approximately 1,070 r.p.m. if operated on a 200-volt line. The nature of the load will affect the speed of a series or compound-wound motor under different voltages. A series motor driving a constant-torque application such as a conveyor will vary in speed directly as the voltage, since the current and therefore the field strength is the same. The same motor driving a fan or blower, where the torque required varies with the speed, will sustain a smaller percentage drop than the voltage because the field is weaker, which tends to increase the speed.

A compound motor driving a constant-torque application will have a lower percentage fall in speed than the voltage because the shunt field has been weakened, even though the series field has been increased, due to the armature current being higher to maintain the torque. Since the torque is proportional to the product of the armature ampere-turns and the field flux, and the armature current has increased, the field therefore must be weaker, which tends to increase the speed. If the load on this motor is similar to a fan, the drop in speed will be less than that for a series motor because the field is weakened not only from a decrease in the series winding current, but also from a decrease in the shunt winding.

It should be noted that since a shunt motor is essentially a constant-speed machine with a given voltage and varying load, the change in load-torque requirements has little effect on the relation of speed decrease to the fall in voltage.

As pointed out before, there is no change in the current capacity of the motor and little change in the efficiency. Therefore, the horsepower capacity is directly proportional to the applied voltage. The efficiency is less with a lower voltage, but unless the motor is used on a voltage less than 75 per cent of the rated voltage, the difference in efficiency can be neglected. If the efficiency of a motor is 85 per cent at full voltage, it will be about 70 per cent at half voltage.

### Operating on High Line Voltage

Operating a motor on a voltage higher than its rating presents problems not unlike those encountered at a voltage lower than rated. The shunt-field winding should be protected against overheating, which may be occasioned if it is subjected to a higher voltage. To what extent the voltage on this winding can be increased will depend on the load, because the temperature of the shunt-field winding is affected by that of the armature. If the armature current falls with the increase of line voltage and speed, the voltage across the shunt-field winding may be allowed to exceed the normal value.

A safe rule to follow is not to allow the voltage across the shunt-field winding to exceed its rated value. With applications requiring an increased torque with increased speed, such as a fan or blower, it may be well to watch both the armature and field windings and protect them from overheating. If the armature overheats, there is little choice but to remove the motor and replace it with one that is large enough for the service. If only the shunt winding overheats, resistance should be inserted in its circuit to reduce the current. This will increase the armature speed, which may cause it to take on more load

and overheat. Therefore, it is clear that caution should be used in applying higher voltages to motors, and they should be watched carefully after starting up the first time on the higher voltage, to see that no part is overheated.

With the voltage on the shunt-field winding held at its normal value, the percentage rise in speed of a shunt motor will be practically equal to the percentage rise in line voltage regardless of the characteristic of the load. A series motor will increase in speed in proportion to an increase in voltage if driving a constant-torque load. If the torque increases, the percentage rise in speed will be less than the percentage rise in voltage because the field will be strengthened. On a constant-torque application a compound motor will also have a speed proportional to the voltage if the shunt field is held to its normal value. If the load is an application where the torque increases with speed, the relation of the speed to the voltage will lie between that of a shunt motor and a series motor. The horsepower capacity will increase directly with the increase in voltage. The efficiency also will be higher.

### Rating of an Inclosed Motor

The ordinary open-type motor can be totally inclosed and continuously operated if the proper precautions are taken. The ability to radiate heat is greatly curtailed by closing the openings in the end brackets. In the open motor there are two channels through which the heat losses of the machine are dissipated. The first and most important is by means of ventilating air. The rotating armature draws in cool air through the bracket openings and causes it to pass through and around the windings, where it absorbs heat before being discharged. The second and lesser means of heat dissipation is by direct radiation from the frame, brackets, etc. When a motor is totally inclosed, the ventilation is entirely cut off and direct radiation from the outside of the machine is the only means of dissipating the heat. For this reason the losses must be materially reduced in order to prevent overheating of the windings if the motor is entirely inclosed.

In a motor the losses can be divided into two general classes, those that are constant and those that vary with the load. In the first-named group are the core loss, brush friction and windage, which are affected but slightly by any changes in load. Little can be done to reduce these losses in a given machine. The copper, or $I^2R$, losses comprise the variable losses and these vary with the square of the load. Therefore, both the load current and the shunt-field current should be diminished when operating a motor inclosed.

When a motor is inclosed the load should not exceed 50 per cent of its open rating and a rheostat should be inserted in the shunt-field circuit which will limit the voltage across it to about 70 per cent of its normal open value. This will, of course, weaken the shunt field, and the motor will run about 35 per cent faster than if operated open. For example, a 10-hp. 230-volt 1,150-r.p.m. 40-deg. C. shunt-wound open motor will carry 5 hp. at 230 volts at about 1,550 r.p.m. continuously with a temperature rise of 55 deg. C. if totally inclosed.

There is a limit to the size of a totally inclosed motor

CHANGED OPERATION CONDITIONS FOR DIRECT-CURRENT MOTORS AND THE RESULTS

| Conditions | 115-V. Motors Shunt or Compound 5 hp., 850 r.p.m. 7½ hp., 1,200 r.p.m. 10 hp., 1,800 r.p.m. | 230-V. Motors Shunt or Compound 5 hp., 850 r.p.m. 7½ hp., 1,200 r.p.m. 10 hp., 1,800 r.p.m. | 550-V. Motors Shunt or Compound 5 hp., 850 r.p.m. 7½ hp., 1,200 r.p.m. 10 hp., 1,800 r.p.m. | 115-V. Motors Shunt or Compound 25 hp., 850 r.p.m. 30 hp., 1,200 r.p.m. 50 hp., 1,800 r.p.m. | 230-V. Motors Shunt or Compound 25 hp., 850 r.p.m. 30 hp., 1,200 r.p.m. 50 hp., 1,800 r.p.m. | 550-V. Motors Shunt or Compound 25 hp., 850 r.p.m. 30 hp., 1,200 r.p.m. 50 hp., 1,800 r.p.m. |
|---|---|---|---|---|---|---|
| To operate at higher speeds by weakening shunt field. Shunt motors may not run steadily at more than 25 per cent increase in speed. | Use field rheostat of 200 ohms 1.5 amp. max. and 0.4 amp. min. capacity. | 1,000-ohm rheostat 0.7 amp. max. and 0.2 amp. min. capacity. | 2,000-ohm rheostat 0.3 amp. max. and 0.15 amp. min. capacity. | 75-ohm rheostat 3 amp. max. 1 amp. min. capacity. | 300-ohm rheostat 1.5 amp. max. 0.4 amp. min. capacity. | 1,200-ohm rheostat 0.5 amp. max. 0.25 amp. min. capacity. |
| To operate on double voltage at double speed. | Use resistor of 85 ohms and 1.5 amp. capacity in shunt-field circuit. | 400-ohm resistor 0.7 amp. capacity. | Not applicable. | 40-ohm resistor 3 amp. capacity. | 165-ohm resistor 1.5 amp. capacity. | Not applicable. |
| To operate on half voltage at half rated speed. | Connect shunt field coils in two parallel paths. Good for half rating only. | | | | | |
| If operated on half voltage without change in motor. | Speed will drop about 30 per cent. Good for half rating only. Shunt motors may have unstable speed characteristics. | | | | | |
| To operate as generator at rated voltage. Run approximately 35 per cent higher than rated speed. | Use field rheostat of 75 ohms and 2.5 amp. max. and 1.25 amp. min. capacity. | 320-ohm rheostat 1 amp. max. and 0.5 amp. min. capacity. pacity. | 1,750-ohm rheostat 0.5 amp. max. and 0.25 amp. min. capacity. | 60-ohm rheostat 4.5 amp. max. 2.5 amp. min. capacity. | 150-ohm rheostat 2.5 amp. max. 1.25 amp. min. capacity. | 1,100-ohm rheostat 0.75 amp. max. 0.4 amp. min. capacity. |
| To operate as generator at highest attainable voltage. Run at 2,250 r.p.m.* | 300-ohm rheostat 2.5 amp. max. 1.25 amp. min. capacity. 850-r.p.m. motor good for 250 volts. 1,200-r.p.m. motor good for 200 volts. | 950-ohm rheostat 1 amp. max. and 0.5 amp. min. capacity. 850-r.p.m. motor good for 500 volts. 1,200-r.p.m. motor 400 volts. | Do not exceed rated voltage. | 125-ohm rheostat 4.5 amp. max. 2.5 amp. min. 850-r.p.m. motor good for 250 v. 1,200-r.p.m. motor good for 200 volts. | 400-ohm rheostat 2.5 amp. max. 1.25 amp. min. 850-r.p.m. motor good for 500 v. 1,200-r.p.m. motor good for 400 volts. | Do not exceed rated voltage. |
| To operate as generator at rated speed. Connect shunt coils in two parallel paths. | Good for 100 v. 40-ohm rheostat 4.5 amp. max. 2.5 amp. min. capacity. | Good for 200 v. 175-ohm rheostat 2.5 amp. max. 1.25 amp. min. capacity. | Good for 475 v. 850-ohm rheostat 1 amp. max. and 0.5 amp. min. capacity. | Good for 100 v. 30-ohm rheostat 9 amp. max. 4.5 amp. min. capacity. | Good for 200 v. 75-ohm rheostat 4.5 amp. max. 2.5 amp. min. capacity. | Good for 475 v. 550-ohm rheostat 1.5 amp. max. 0.75 amp. min. capacity. |
| To operate as generator at half voltage. Connect shunt coils in two parallel paths. Run at about 70 per cent rated speed. | 20-ohm rheostat 4.5 amp. max. and 2.5 amp. min. capacity. | 80-ohm rheostat 2.5 amp. max. 1.25 amp. min. capacity. | 450-ohm rheostat 1 amp. max. 0.5 amp. min. capacity. | 15-ohm rheostat 9 amp. max. 4.5 amp. min. capacity. | 40-ohm rheostat 4.5 amp. max. 2.5 amp. min. capacity. | 275-ohm rheostat 1.5 amp. max. 0.75 amp. min. capacity. |
| To operate as generator at lowest attainable voltage. Connect shunt coils in four parallel paths. Run 850-r.p.m. motor 325 r.p.m. Run 1,200-r.p.m. motor 425 r.p.m. Run 1,800 r.p.m. motor 600 r.p.m. | Good for 30 v. 5-ohm rheostat 9 amp. max. and 4.5 amp. min. capacity. | Good for 60 v. Use 20-ohm rheostat 4 amp. max. and 2 amp. min. capacity. | Good for 140 v. Use 110-ohm rheostat 1.8 amp. max. and 1 amp. min. capacity. | Good for 30 v. 4-ohm rheostat 18 amp. max. 9 amp. min. capacity. | Good for 60 v. 9-ohm rheostat 9 amp. max. 4.5 amp. min. capacity. | Good for 140 v. 70-ohm rheostat 3 amp. max. 1.5 amp. min. capacity. |

*Do not run any machine above 2,250 r.p.m. unless made special for high speeds.

because in a large machine the surface area from which the heat can radiate is less in proportion to the losses than in a smaller machine. This limit as to size is also governed by the speed of the machine because for a given frame size a high-speed machine has higher windage, brush friction and core losses than does a slower-speed armature. For motor sizes the limit at 1,100 r.p.m. is about 40 to 50 hp., while at 1,750 r.p.m. no more than about 15 hp. can be obtained from any machine that depends upon radiation alone. A larger machine will have higher no-load losses and little increase in surface area, so that the output will be no greater than the figures given. Suppose a given motor has a maximum continuous rating of 15 hp. at 1,750 r.p.m. and 55 deg. C. when inclosed and is found inadequate for the service and is replaced with a larger motor, it will be found that the larger motor will do no better than the smaller one, and that it also is good for only 15 hp. at this speed. Such a condition can be overcome by using two motors in parallel or by force ventilating the original machine.

On the chart are given data that are to serve as a guide in calculating the capacity of rheostats and the connections for motor changes. The figures are only approximate, but are close enough to obtain satisfactory results with most modern machines.

## Answers to What Do You Know

*The questions are on page 237*

Ans. 1—The noise is caused by drops of water coming through with the steam. These are sometimes reevaporated by frictional heat and produce an explosive sound. This is perfectly normal and indicates no real trouble, usually occurring when glands are tight and in good condition, and gradually disappearing in time.

Ans. 2—In a slide-valve engine cutoff before the end of the stroke is obtained by setting the eccentric more than 90 deg. in advance of the crank, and that hastens all the valve events. The lead must be corrected by adding lap to the valve. There is then less valve opening and also slower motion of the valve at the points of opening and closing, because those events occur when the eccentric is nearer its dead center, and therefore shortening of the cutoff is accompanied by wiredrawing the steam, and there is realization of considerably less than steam-chest pressure, even at the beginning of the stroke. Hastening of the release is accompanied by hastening closure of the exhaust. If the release is delayed by adding lap to the exhaust edge of the valve, less exhaust opening is obtained, the back pressure is further increased by earlier closure of the exhaust, and the resulting compression may be so excessive as to force the valve from its seat and thus permit leakage of steam from the steam chest directly to the exhaust outlet of the engine. These considerations affecting the action of the plain D slide valve have established a limit to which it may be economically used. It is sometimes employed for cutoff at one-half, but as a rule, with a fixed eccentric, not earlier than five-eighths stroke.

Ans. 3—The force of governor springs and effective centrifugal force of the weights are unbalanced and alternate in overcoming each other. The remedy is to give less tension on the springs to decrease sensitiveness, and changing the weight to get the desired speed. Hunting and racing may be caused also by friction of the governor parts or connections. When caused by friction, the weights will remain on their inner position until the speed developed is so high as to throw them out with a noise; or when the engine is above speed they will stick where they are until the speed is reduced enough for the springs to draw the weights back again.

Ans. 4—The portion of the plates forming the laps of the circumferential joints where exposed to the fire or products of combustion, should be planed or milled down to $\frac{1}{2}$ in. in thickness to render the plate thin enough for the plates and rivets at the joints to be kept sufficiently cooled by the water of the boiler to prevent their becoming burned. While this reduction of thickness lowers the strength of the joint, it may be reduced to only 35 per cent of the strength of the longitudinal joints, provided 50 per cent or more of the load that would act on an unstayed solid head of the same diameter is relieved by the effect of tubes or through stays, and in that way plates of unusual thickness and longitudinal joints of highest efficiency may be employed with circumferential joints planed down to $\frac{1}{2}$ in. in thickness without reduction of working pressures below those appropriate to the strength of the longitudinal joints.

Ans. 5—When steam flows through an aperture, the discharge takes place in consequence of the difference in pressure on opposite sides of the aperture, and in its passage through a reducing valve or other form of opening, without doing any external work, there is neither loss nor gain of total heat per pound of the steam. As the total heat in a pound of saturated steam decreases with a decrease in pressure, ordinarily after expanding to a reduced pressure, each pound of the steam contains more heat than necessary for saturation or the same percentage of dryness that it had at the initial pressure; so that the process of wiredrawing, whether performed by passing the steam through a throttled valve, a pressure-reducing valve or other form of aperture, converts wet steam into a drier steam at the lower pressure, dry steam to steam that is superheated for the lower pressure, or may convert superheated steam to steam at a lower pressure with more degrees of superheating for the lower pressure than it had for the initial pressure. But the temperature is lower than it was at the higher pressure.

Ans. 6—The advantage over single-stage compression is an appreciable saving of power and the avoidance of the high temperatures, thus permitting more satisfactory lubrication and less oil discharge in the receiver and piping system to cause fires and explosions, and less drop of pressure from cooling of the compressed air.

Ans. 7—Chemically pure water is an insulator of electricity, but when water is contaminated with almost any other substance it becomes a conductor.

Ans. 8—If the capacity of the plant has dropped and the head pressure persists in keeping high, foreign gases are usually the cause. To detect such gases, insert a hose connected to the condenser purge valve in a pail of water. The ammonia gas will be absorbed by the water, while any foreign gas will bubble.

Ans. 9—The jumping indicates presence of air and may result from running the pump too fast, or the pump design may be such that the water is not always rising and there are pockets where air can accumulate.

Ans. 10—When a proper weight of duck is used in rubber belting, four-ply rubber belting is taken to have the same transmission capacity as good quality, single-thick leather belting of the same width; six-ply rubber the same capacity as double-thick leather belting; and eight-ply rubber the same capacity as triple-thick leather belting.

# Reducing Transmission Losses by Diesel Engine Stations

## Advantages of Diesel Plants for Transmission Lines—Reduction of Line Losses and Increase in Carrying Capacity—Actual Plants Now in Operation

By S. A. Hadley

THE advent of long-distance transmission of electrical energy has brought with it problems that become more intensive as length of the transmission line increases, until in certain instances the line loss has become almost prohibitive. Granted that an electric system is able to obtain a better load factor than in case of a central section with closely knit lines, it is questionable if the final economy is at all attractive as long as the energy is produced in a single plant. On the other hand, Diesel plants situated in strategic localities along the transmission line would reduce the losses and decrease the cost of power delivered to the customer. Steam central-station plants of large size and modern design under favorable conditions are producing power at rates of from 12,600 to 18,000 B.t.u. per kilowatt-hour. At the relative price of coal and oil prevailing in some places this gives a lower fuel cost at the generator terminals than the fuel cost of the average Diesel plant. But steam plants have certain essential requirements for good efficiency, such as large size, continuous operation, a good load factor and a natural water supply suitable for condensing purposes. This apparently impels the construction of large or so-called "superpower" stations close to a large body of water.

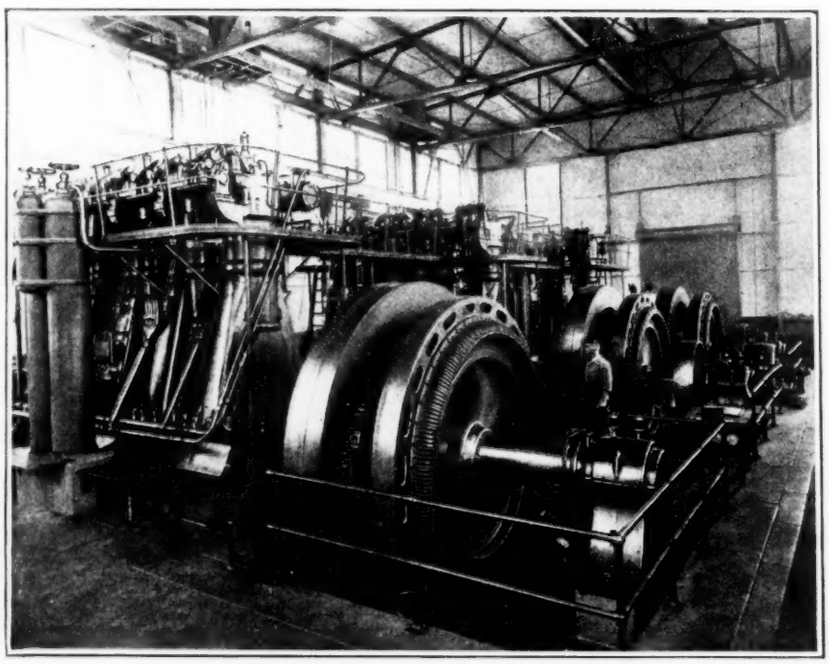


*Fig. 1—The Paris, Texas, 1,500-hp. Diesel station operates in parallel with steam plants*

If, for the sake of efficiency, the generation of power is concentrated into large units whose output cannot be absorbed close by, but must be distributed over a large territory to find users, then the losses, both direct and incidental, that are inseparable from such distribution should be subtracted from the performance of the plant when making a comparison with a system of smaller units of nearly equal efficiency situated so as to reduce the distribution losses.

The power lost at constant potential is proportional to the square of the power transmitted. In such a case the relief to be had simply from boosting the voltage as much as can be done with the same line, is rather small and any gain in power transmitted is accompanied by increased likelihood of trouble and by increased losses. So it soon becomes necessary to build another line or rebuild the existing line, possibly for higher voltage and in any case at increased cost, and to add step-up and step-down transformers. The building of a Diesel-engine generating station at some point on the line is another way of meeting the situation, and it is the purpose to show that the peculiar characteristics of the Diesel engine are of especial advantage for that purpose.

We will consider only their general application, as the exact values for any situation can be determined only by a calculation of the load factor and characteristics of each separate section of the line. Nevertheless, the governing factor is Kelvin's law of maximum economy, which says that "the annual cost of the energy wasted per mile of the transmission line added to the annual allowance per mile for depreciation, and interest on first cost shall be a minimum." Other conditions, such as excessive heat-

ing, want of mechanical strength or losses by corona discharges, will influence the size of conductors and the cost of line per mile and will help to determine the location of the auxiliary station.

It will work out as if the transmission represented a body of irregular outline and of varying specific gravity which is too weak for its mass to be supported at one point only, but must have two or more points of support. One of these, represented by the large central station, can carry the most of the weight without injury to itself or to the body. The other point or points, represented by the Diesel station or stations, may be considered as being able to carry only a limited part of the mass. We can fix the relative location of the Diesel plant on the system just as we can determine the center of gravity and the points of support of such an imaginary body. Probably the Diesel station will be located between the center and far end of the line, at a point where a considerable block of power, but less than the capacity of the Diesel plant, is used.

There would be several advantages. First, there would be the main object of the change, the great increase of line capacity for the same voltage drop. There would be a net useful addition to the system considered as a whole of not only the additional capacity of the auxiliary station at a cost not much different from that of adding the same capacity in the main station, but also the addition of the power that had been lost in the overloaded transmission system, which might exceed 20 per cent. The designed loss from potential drop would probably be between 5 and 10 per cent, and much of this can be saved. Under most load conditions there would be greatly improved regulation. Some power-factor correction could be had wherever the load permits the Diesel plant or even one unit of it to be shut down. The engine may be run with fuel cut off from most cylinders, the governor set to give a speed just under the line frequency, so that the generator with fields over-excited will float on the line and act as a synchronous condenser.

Increased safety and service may be given by the additional source of power near the center of use, referring to the territory served by the transmission line. This will be particularly true if the auxiliary plant is located where a large block of power is used which can be served by the generating voltage. This cuts out the loss in step-up and step-down transformers for that much power and the losses incidental to transmitting that power over a considerable length of line at high voltage.

When we consider the relative capital outlay for the two plans, the first being service over a transmission line taking power from one end only and the other being a line from a large well located and efficient central station helped out by an auxiliary Diesel station suitably placed, we shall find a good deal to offset the investment in the Diesel station. The Diesel-engine station complete with equipment, fuel storage, cooling tower or spray pond and building will range between $100 and $125 per kilowatt of capacity, which is not far from the cost of the same equipment at the larger station. If the plant is located where a large part of its output can be used at the voltage at which it is generated, there will be saved the cost of the step-down transformers that would otherwise have to be furnished to serve that community from the line. It is true there would have to be step-up transformers to deliver the current from the Diesel equipment to the line, but that will be offset by having to put about that much less step-up transformer capacity at the other end of the line. The slight difference in cost of transformers per unit of capacity which is in favor of the larger unit will be more than offset by the fact that step-up transformers located at the beginning of the line would have to be larger so as to take care of losses in the line.

Finally, there is the cost of the line itself, or rather the value of the increased capacity given the line by the addition of a Diesel station near its end. We will assume in round figures that a 50-mile line for an input of 4,000 kw. costs $150,000. With this line well loaded there will likely be a loss of from 1,000 to 1,250 kw., leaving but 2,750 to 3,000 kw. available for use.

The idea considered for study is how much more current can be delivered to the community served by this line by the addition of a Diesel station of, say, 2,250 kw.

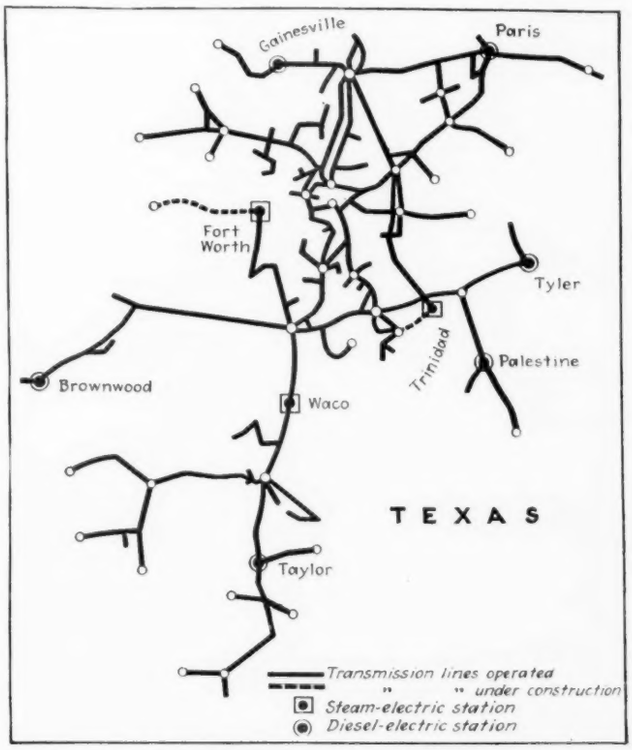



*Fig. 2—The Texas Power & Light Co.'s system with steam and Diesel plants*

at some point on the farther half of the line, where a considerable block of power can be utilized at the generating voltage, and what will be the increased total capital charge. These figures cannot be made exact without a careful study of each section of the line and the service required from it. The investment in the auxiliary Diesel station should be balanced against the cost of changing or adding to the line to allow it to deliver double the amount of current plus the cost of the additional central-station equipment in the main station to deliver this additional current plus the losses in the line.

Besides the comparison from the point of investment and earnings, there is also the point of better service to be expected from an additional plant located much nearer the point of general use.

The same reasons that would justify adding an auxiliary Diesel station to an overloaded existing transmission system might also justify the building of such a composite system when the line is first projected. In

fact, several such systems have been in operation about ten years in northern Texas in which the auxiliary Diesel plant was completed before the line was built.

The Texas Power & Light Co. was reaching into new territory and acquiring outlying properties which they expected to run from a large steam station to be built on the Brazos river at Waco. These properties had steam plants of small size and poor efficiency, and it was planned to build Diesel stations at points where short lines would reach several smaller communities. The high efficiency of the Diesel plant would allow rates to be made much lower than had been possible with the small steam plants, and a good load could be quickly built up which it was planned to put on a transmission line from the big steam station a little later. The Diesel engines were then to be removed to repeat the process elsewhere.

The Diesel stations were built, lower rates made, the load built up and some of the lines built all as planned. But the Diesel engines proved so efficient and the advantages of generating a part of the power near the end of the line so attractive that after a little experience it was decided to leave the Diesel stations alone and buy more engines as needed for new development. Such auxiliary Diesel stations have been in service at Palestine, Paris, Tyler and Brownwood, Texas, for over ten years. One of them, at Paris, containing three 500-hp. engines is now in its thirteenth year of operation with no impairment of original efficiency. It has been used as a baseload station, supplying Paris and feeding all possible surplus into the line. The station load factor has been never less than 85 per cent for any year and has usually been around 93 per cent.

### Low Cost of Moving Diesels

The decision to hold the engines where originally installed was not from any difficulty or great expense of moving. The cost of moving, that is, taking down, loading in cars, unloading and re-assembling would usually be between $15 and $20 per ton or $2.70 to $3.60 per horsepower since the engines, generators, exciters, pumps and piping will average about 360 lb. per hp. It is quite different from the steam plant, which has little salvage value because so much goes into boiler settings, stacks, water supply and cooling equipment which cannot be moved.

One of the most efficient and profitable plants of the great Middle West Utilities Co. located at Mission, Texas, contains two 1,000-hp. Diesel engines which have been moved twice previously from mining properties and are now working on their third foundations. These engines are tied in over approximately 100 miles of line with a steam station of about 6,000 kilowatts.

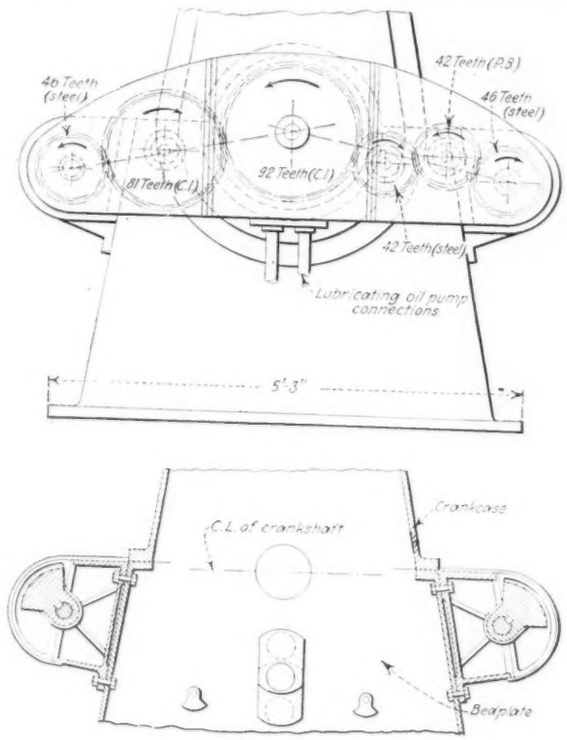
Another more recent installation of this kind is at Nevada, Missouri, where a 600-kw. single Diesel engine and generator unit in that station is tied over about 125 miles of line with another Diesel station of smaller size at Warrensburg and two steam stations of about 3,000 kw. each.

Where the transmission system serves a closely congested district, the line loss probably is not sufficient to justify a number of Diesel-engine stations. However, the larger number of systems serve a comparatively scattered population, and, as has been stated, the consequent line loss makes the cost of the delivered energy far above that jutified by the actual production expense. On many of these systems, Diesel plants would raise the load factor and decrease the total investment, both of which are of interest to the producer and consumer.

## Balancing Large Oil Engines

IN THE June 24 issue of *The Engineer*, London, was described a balancing gear used in a 4-cylinder 250-hp. oil engine built by the W. H. Allen Sons & Co., Ltd. This engine has its four cranks in one plane and, as it was to be installed in the "Empress of Australia," entire absence of vibration was desired.

With a four-cylinder unit, which was essential to meet the space and output conditions, the out-of-balance forces were admittedly greater than those of a six-cylinder unit, and for this reason balancing gear was proposed by the technical department of the Fairfield Shipbuilding & Engineering Co., Ltd., and it was then adopted, worked out and applied to the engines in question by the design-

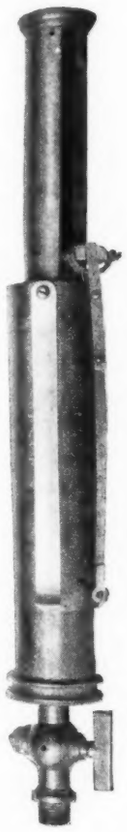



*Balancing device for oil engines*

ing staff of the engine builder. From the illustration it will be seen that the gear consists essentially of two gear-driven shafts, one on either side of the engine bedplate, to which the sector-shaped balance weights are keyed. A cast-iron spur wheel, with 92 teeth, is mounted on a spindle in line with the crankshaft center, and is carried on bushed bearings formed in the gear case and its cover. This spindle is driven from an extension of the crankpin of the air compressor. On the left-hand side of the engine looking from the end, there is an 81-tooth cast-iron intermediate wheel, which drives the 46-tooth steel wheel on the balancing shaft in an anti-clockwise direction. On the right-hand side two intermediate wheels, each having 42 teeth, one of steel and the other of phosphor bronze, are interposed, and they drive a similar steel wheel on the other balancing shaft, which runs, however, in a clockwise direction.

In the lower view a diagram showing the correct position for setting the balance weights relative to the position of the engine cranks is given. There are, in addition, concentric masses fitted on the shafts between cylinders No. 1 and No. 2, which increase the inertia of the balancing system.

# Another Old Indicator



LAST year (Dec. 21, 1926, issue) *Power* showed a photograph of an old steam engine indicator made in 1842 by Trafton in Worcester, Mass. More recently there has been contributed to the Museum of the Peaceful Arts, New York, by Raymond Seabrook a still older instrument of a similar type made by Watkins & Hill, London, in 1836. This is called "Macnaught's Improved indicator" and is accompanied by a pamphlet not only giving full directions for its use but containing also a low-pressure steam table. The pamphlet adds intrinsically to the historical value. The sketch, also reproduced from the pamphlet, shows the indicator attached to a beam engine of the low-pressure type. Excerpts from the text follow:

"The indicator is an instrument for measuring the power exerted by steam engines. It exhibits the density of the steam in the cylinder, and the quality of the vacuum at every part of the stroke. It is simple in its construction and easily understood and applied. By it a steam engine proprietor can ascertain in one minute the working conditon of his engine; he can detect neglect in his engineer; can demonstrate the proportion of power required to overcome the friction of the engine; to give motion to the shafts and mill gearing, or to drive the machinery; he can tell the power expended in driving any part of his works; or if power is let off, he can at any time prove what power his tenant consumes; he can ascertain the friction of the machinery, when using different oils; and can guide himself with certainty in the choice of that which is best. He can ascertain the expenditure of steam when injecting water of different degrees of temperature; and can compare the saving arising from the use of cold water with the expense of procuring it.

"The maker of this instrument hopes that while he improves his resources by the sale of this instrument, the public in return will be benefited by its utility.

"The cylinder of the indicator is equal to ¼ of a square inch, the divisions on the scale 1-10th of an inch, each division representing 1 pound of pressure on the square inch of the piston. When the cocks are shut, the index will stand at 0, or zero; when opened, the pressure of steam will be exhibited above 0 or zero, and the vacuum below.

"To find the power the engine is exerting, find the square inches in the area of the cylinder, multiply by the average pressure, and by the number of feet the piston travels in a minute, divided by 33,000, the number of pounds a horse can raise one foot high in a minute, which gives the horsepower. Engineers reckon 10 lb. for average pressures, and only 7 for effective power, that is allowing 3 lb. to be consumed by the engine itself.

"From what is shown by the different diagrams, it will be readily observed, that ports of a sufficient size and plenty of cold water are absolutely necessary to make an engine perform well; the different diagrams will explain the first, and the tables from experiments made by Dr. Ure and Mr. Dalton will show the force the vapour, or uncondensed steam, has to resist the descent or ascent of the piston, which will be according to the temperature of the water discharged by the air pump.

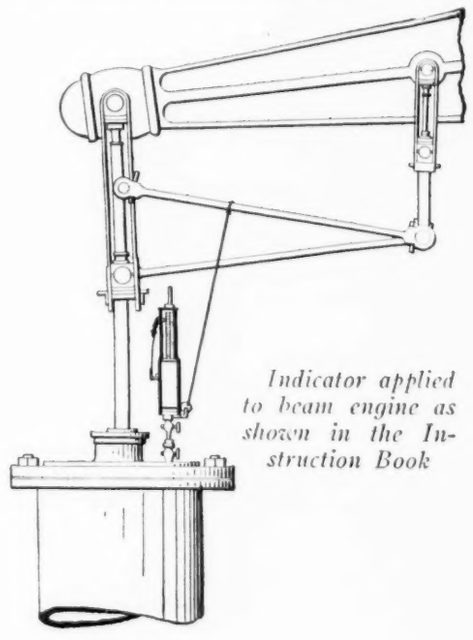
| Fahrenheit Temperature | Force in Inches of Mercury | | Libs | Fahrenheit Temperature | Force in Inches of Mercury | | Libs |
|---|---|---|---|---|---|---|---|
| | URE. | DALTON. | | | URE. | DALTON. | |
| 32 | 0,200 | 0,200 | 0,100 | 130 | 4,36 | 4,34 | 2,17 |
| 40 | 0,250 | 0,203 | 0,123 | 135 | 5,07 | 5,00 | 2,52 |
| 50 | 0,360 | 0,303 | 0,181 | 140 | 5,77 | 5,74 | 2,88 |
| 55 | 0,416 | 0,449 | 0,215 | 145 | 6,60 | 6,53 | 3,28 |
| 60 | 0,516 | 0.524 | 0,200 | 150 | 7,53 | 7,42 | 3,74 |
| 65 | 0,630 | 0,610 | 0,311 | 155 | 8,50 | 8,40 | 4,22 |
| 70 | 0,726 | 0,721 | 0,361 | 160 | 9,60 | 9,46 | 4 76 |
| 75 | 0,860 | 856 | 0,428 | 165 | 10,80 | 10,68 | 5,37 |
| 80 | 1,01 | 1,01 | 0.505 | 170 | 12,05 | 12,13 | 6,01 |
| 85 | 1,17 | 1,17 | 0 585 | 175 | 13,55 | 13,62 | 6,75 |
| 90 | 1,36 | 1,36 | 0,680 | 180 | 15,16 | 15,15 | 7,58 |
| 95 | 1,64 | 1,58 | 0,805 | 185 | 16,90 | 17,00 | 8,47 |
| 100 | 1,86 | 1,86 | 0,900 | 190 | 19,00 | 19,00 | 9,50 |
| 105 | 2,10 | 2,18 | 1,07 | 195 | 21,10 | 21,22 | 10,58 |
| 110 | 2,53 | 2,52 | 1,26 | 200 | 23,60 | 23,64 | 11,81 |
| 115 | 2,82 | 2,92 | 1,43 | 205 | 25,90 | 26 13 | 13,01 |
| 120 | 3,80 | 3,33 | 1,50 | 210 | 28,66 | 28,84 | 14,43 |
| 125 | 3,83 | 3,79 | 1,902 | 212 | 30 | 30 | 15 |

*Reproduction of the Steam Table*

"The column marked Libs is made by adding the results of Dr. Ure's and Mr. Dalton's experiments together and taking the average, and stating a column of Mercury of 30 inches high at 15 lb.

"The instrument will apply equally well to the condenser, or pumps, by having a cock made to fit it in any convenient situation, and will answer all the purposes of the Mercury barometer, and also to try the pressure of steam in the boiler, when it does not exceed 9 lb. upon the inch."

The booklet also makes reference to another instrument, a high-pressure indicator for pressures up to 50 lb.



*Indicator applied to beam engine as shown in the Instruction Book*

# Experiences with Diesel Engines In a California Ice Plant

## Oil Engines Give a Low Cost per Ton of Ice—High Atmospheric Temperature Prompted Cooling of Engine Air—Noise of Exhaust Silenced.

THE power problem of an ice plant is in some respects similar to those of a central station. Other than labor the major cost of a pound of ice is due to the engine-room expense. For this reason ice plants endeavor to reduce the power costs by installing econominal generating units.

It was this which prompted the Holtville, California, Ice & Cold Storage Co. to install a 75-hp. two-stroke-cycle Diesel. This was direct connected to an 8x8-in. duplex single-acting compressor and belted to a 30-kw. generator.

Production increased so rapidly that the engine was soon loaded in excess of its capacity, and so, early in 1926, an 80-hp. Diesel driving a 9x9-in. ice machine was installed. This additional unit remedied the load condition, and the plant operated quite satisfactorily through the fall. During this time, however, production was increasing rapidly, and so it was decided to install a third unit, and this time the unit selected, a 240-hp. Diesel, was large enough to take care of a considerable growth in business.

At the time of the installation of the 240-hp. unit a

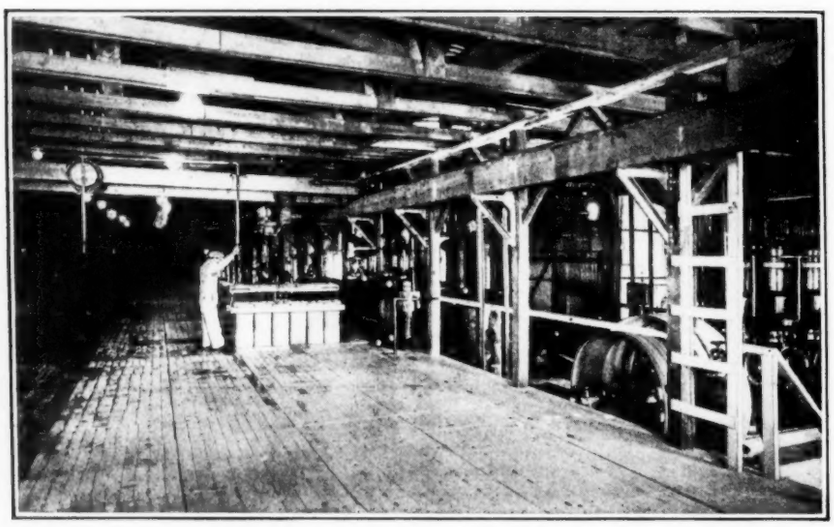


*Fig. 1—Ice tank deck with the three Fairbanks-Morse Diesels at the right*

number of changes were made in the plant. The cooling-water problem had become a very serious one owing to the fact that the atmospheric temperature at Holtville in the summer often reaches 125 deg. F. and will average 118 deg. Nor was the high temperature the only problem encountered in the cooling-water problem, for the wind at Holtville carries large amounts of fine sand and an unbelievable number of winged bugs.

In order to take care of the cooling water, a tower 30 ft. high and with a 30x30-ft. base, having unusually large louvers was installed with a bank of coils in the bottom of ample capacity for cooling the water for all three units. Duplicate motor-driven circulating pumps were provided for each engine and a complete closed coil circulating system utilized, thereby eliminating all danger from scale, which had given some trouble in the first installation.

In order to clean the air and at the same time cool it

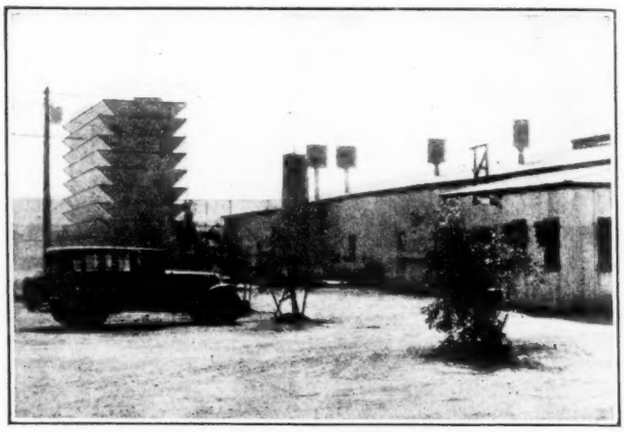


*Fig. 2—View of the cooling tower*

before admitting it to the crankcase, a rather novel plan was employed, which has worked out in a very satisfactory way. A 24-in. cement pipe 25 ft. long was installed in the bottom of the cooling tower about 2 ft. above the water level, as shown in Fig. 3. This pipe is closed at both ends, but has a series of 4-in. openings in the bottom which are spaced 3 ft. apart. Midway in the length is connected a second 24-in. cement pipe which runs horizontally into the engine room and branches through smaller lines to the air intake of each engine.

The air supply from beneath the cooling tower is approximately 30 deg. F. cooler than the atmosphere. With temperatures of the atmosphere running as high as 125 deg., this cooled and cleaned scavenging air is of considerable advantage in keeping the pistons and bearings cooled. In addition the weight of the cylinder air charge is increased by the cooling. There has been no evidence of condensation or passage of moisture to the engine, and dust appears to have been completely eliminated.

Since this plant is close to town, it was necessary that the engines be silenced and so mufflers were placed at the top of each exhaust pipe. These mufflers have been found effective, and the exhaust is practically inaudible one hundred yards away and there is no noticeable back pressure in the exhaust.

The engines are of the two-stroke cycle type using the crankcases for the scavenging air pumps. The operating men, although unfamiliar with oil engines at the beginning, have had no difficulty in keeping the units in condition, and no more men are needed than in the case of electric driven units.

Operating costs have been low. During the month

of February the log sheets of the plant showed the following data:

| | |
|---|---|
| Total daily average fuel consumption, gal | 487 |
| Total daily average fuel cost | $29.70 |
| Daily average lubricating oil consumption, gal | 12.6 |
| Daily average lubricating oil cost | $6.97 |
| Tons of ice, average per 24 hours, tons | 98.5 |
| Average fuel cost per ton | $0.301 |
| Average lubricating oil cost per ton | 0.071 |
| Average supplies cost per ton | 0.04 |
| Water cost for ice | 0.39 |
| Labor cost | 0.37 |
| Total cost per ton | $1.172 |

The average head pressure was 132 lb. and the suction pressure 21.4 lb. The average temperature of brine in the tank was held at 13½ deg. and the average temperature in the storage house at 19 deg.

The number of men employed in the plant was 3 in the engine room, 3 in the tankroom and 1 wiper.

With the particular conditions of operation the fuel cost of 30.1c. per ton is quite good, although the lubricating oil cost of 7.1c. is rather high. This was due to the fact that the 240-hp. unit had just been placed in

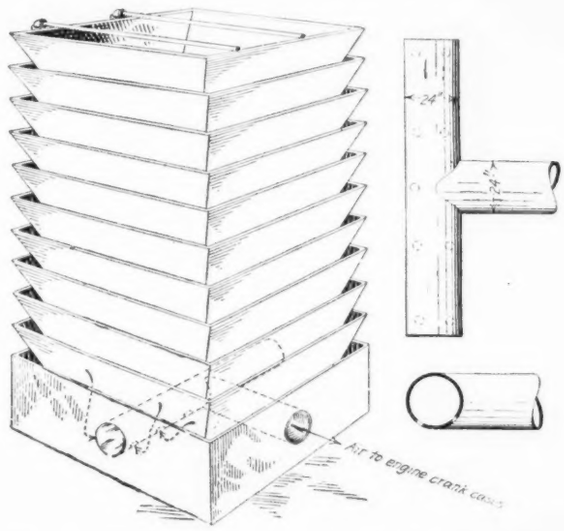



*Fig. 3—Method of cooling the air for the engines*

operation and the rate of feed in the mechanical lubricator had not yet been cut down to the minimum. During the month the 75- and 80-hp. engines ran throughout the entire month with the exception of two short stops required for cleaning the ports. The 240-hp. unit ran practically the entire month, but was stopped several times for inspection and for adjustment.

## Boiler Explosion at Woodstock, Illinois

By J. D. Noonan

THE damages the rupture of even a small boiler can do may be seen from the illustrations, which show the results of a boiler explosion that occurred June 20, 1927, in an educational institution at Woodstock, Illinois. Fortunately, there were no personal injuries, the accident occurring in the early morning hours when the premises were unoccupied. Had it taken place one hour later, there would have been many children in the building. There was a property loss of $6,000.

The boiler was of the vertical fire-tube type, 30 in. diameter by 6 ft. 6 in. high. It projected upward, tearing through the upper floors and roof, and fell back through the roof opening torn during its upward flight, finally coming to rest on the second floor.

The initial rupture occurred in the firebox inner shell just above the Ogee curve, where corrosion had thinned

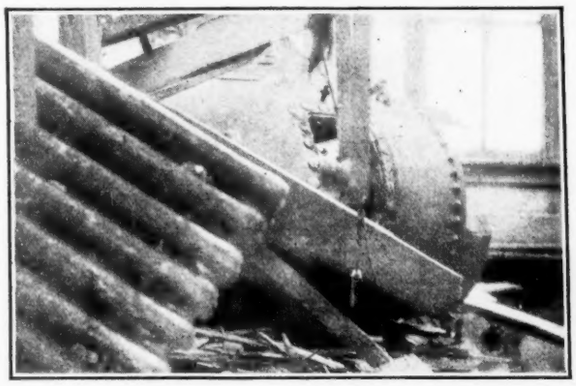


*Fig. 1—Boiler after it came to rest on the second floor*

the metal to a remaining thickness of $\frac{1}{16}$ in. This is clearly a case where the supposedly safe pressure overcame the holding power of the deteriorated sheet. Shortly before the explosion the attendant observed ample water in the gage glass and 75 lb. pressure on the steam gage. The safety valve was set at 100 lb.

It was stated that the boiler was purchased from a second-hand dealer twelve years ago. Its history could

*Fig. 2—Boiler made hole in the roof and forced open one side of the house*

not be traced beyond that time. No legislation governed its operation or inspection, and as it was not insured against explosion, it received no inspection service. Effective boiler inspection would have detected the defective condition, and no qualified inspector would have allowed it to be operated without repairs. The accident proves that mere size does not determine the danger factor in steam heating boilers.

*Supervising engineer, Ocean Accident & Guarantee Corp., Ltd.

# New Pumping Efficiency Set by Centrifugal Water-Works Pump

## Worthington motor-driven pump attains an over-all efficiency of 84.7 per cent—Guaranteed performance predetermined by tests on model pump

TESTS on a 50- and a 70-million gallons per day motor-driven centrifugal pump installed in the Detroit, Mich., municipal waterworks gave results that surpass any previous record, an efficiency, including motor losses, of 84.7 per cent being obtained.

Water for the City of Detroit is handled by two pumping stations, known as stations No. 1 and No. 2. Station No. 1 was equipped prior to the year 1924 with seven reciprocating steam pumping engines having a total capacity, against heads of from 120 to 190 ft., of 162,000,000 gallons per 24 hours. Station No. 2 had six reciprocating pumping engines having a daily capacity of 201,000,000 gallons per 24 hours against a 190-ft. head. These pumps delivered water to three distinct distribution systems against the following pressures: High, 75 lb. per sq.in.; intermediate, 65 lb. per sq.in.; low, 50 lb. per sq.in. In 1925 the demand for water had become so great that steps had to be taken to increase the pumping capacity to forestall a water shortage. It was decided to remove two of the steam pumping engines in Station No. 1 and to replace them with motor-driven centrifugal pumps.

In October, 1925, contracts for the centrifugal pumping units were entered into with the Worthington Pump & Machinery Corp. This contract called for two 36-in. centrifugal pumps direct-connected to electric motors, and all auxiliary equipment, such as switchboard equipment, control apparatus and pump priming arrangements, to be installed by the contractor on foundations provided by the city. As the city was facing a water shortage condition, the time available between the letting of the contract and its completion was short, especially so in view of the fact that a number of unusual problems had to be met. It was specified that one of the pumps be able to deliver 50 million gallons per 24 hours, and the other, 70 million gallons, each against 170 ft. head. The casings for both pumps were to be the same, and the pumps were to be designed so that the one of smaller capacity

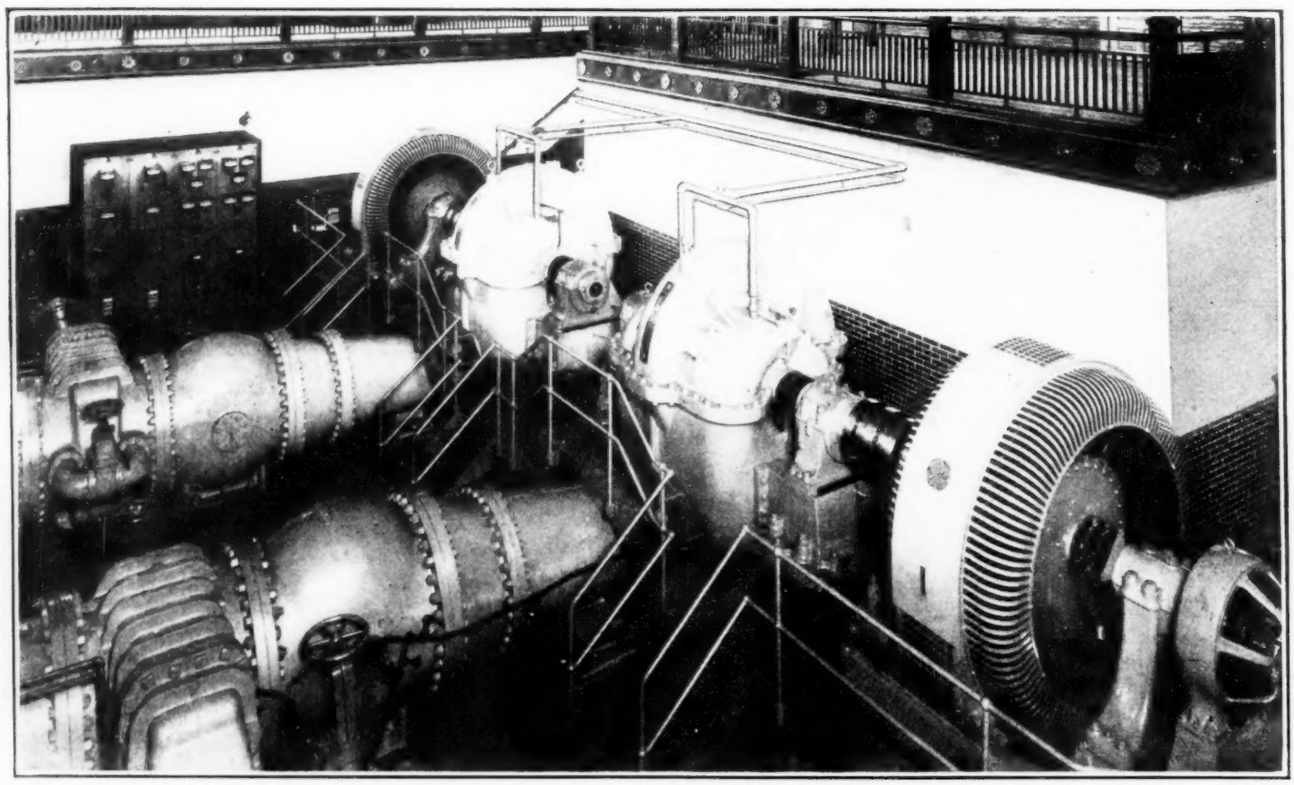


*Fig. 1—Centrifugal pumps in Detroit waterworks*

could be converted at some later date to have a capacity of 70 million gallons with no change except in the impeller. In addition to this unusual condition to be met, high efficiency was required for both units.

An over-all efficiency of the combined electric motor and centrifugal pump of 80 per cent was required for each of the two units. A bonus was offered for each additional one per cent efficiency over 80 per cent up to a maximum of 85 per cent. At the same time a penalty was imposed for each one per cent below 80 per cent,

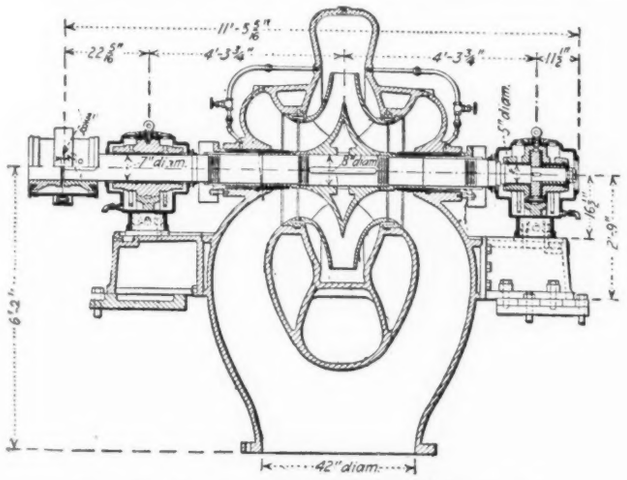



*Fig. 2—Cross-section of the 36-in. pump*

with an option on the part of the city to reject the units if the over-all efficiency did not exceed 78 per cent. In addition, since the city was facing a water shortage condition, it was important that the pumps be in service at a specified time and that no alterations or adjustments be required.

## Double-Suction Volute Type Selected

The City of Detroit selected the double-suction volute type of pump with horizontal shaft. The contractor decided that the most satisfactory way of developing the details of the design for these pumps would be through the adoption of the model system already well established in the engineering of hydraulic turbines. In this way it was planned to produce a high-efficiency pump of a wholly new design in the minimum length of time. It was considered a certainty that the tests of the model pump would predetermine the characteristics of full-sized pumps and that full-sized pumps could be put into service immediately after erection, without changes or alterations.

Designs for the full-sized pumps were immediately prepared on the basis of established experience. Simultaneously, two 10-in. geometrical model pumps similar hydraulically to the full-sized units, were designed and placed in immediate production. Two model casings differing slightly from each other were constructed and tested. From the tests of these models two conclusions were drawn. One involved the modification of some of the details of the full-sized pump, the main parts of which were in production. The other conclusion was the predetermination of the characteristics of the full-sized pumps.

The final units were tested, after installation at Detroit, in January, 1927, by William C. Rudd, assistant engineer of power, Department of Water Supply, City of Detroit, with all parties concerned present.

The results of these tests are given by the two sets of characteristic curves for the 50 and the 70-million gallon units respectively, shown in Figs. 4 and 5. It will be noticed that the larger unit showed a maximum efficiency of pump and motor combined of 84.7 per cent, and a pump efficiency, based on test of the driving motor, of 88.5 per cent under the contract capacity rate at a head of 170 ft. This is the world's record. The 50-million gallon unit showed a maximum combined efficiency of 82.7 per cent and a pump efficiency, based on test of the driving motor, of 86 per cent, which is remarkably high, considering the fact that it was required that both pumps have the same casing.

## The Driving Motors

The motors for driving the pumps are General Electric synchronous with direct-connected exciters, the motors running at 514 r.p.m. The full-load rating of the motor for the smaller pump is 2,050 hp., while that of one for the larger unit is 2,600 hp.

The closeness with which the performance of the full-sized pump was determined in advance by the performance of the model pump is shown by the almost coincidence of the two sets of curves in both charts. It will be noticed that these curves show that the performance of the 70-million gallon unit is practically coincident with that computed from the model tests. The performance of the smaller unit departs somewhat from the model, but this slight divergence was anticipated by the designers.

## Advantages of Model System

Among the other great advantages of the model construction and test procedure, was the elimination of shop tests of the main units, except, of course, hydrostatic and balancing tests. It was thus possible to meet contract conditions as to special design, high efficiency and short delivery with positive assurance as to the performance of

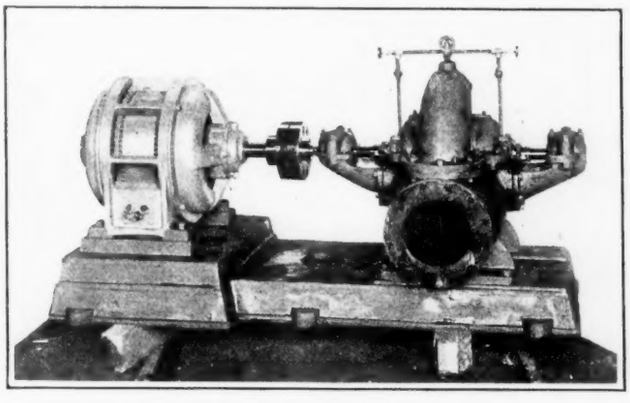


*Fig. 3—The 10-in. model pump used in tests*

the main units. The significance of this fact will be appreciated if it is remembered that test conditions for the model pumps could be closely regulated, while, in the full-sized units, conditions of operation during a shop test vary from those required, even when excellent laboratory facilities are available.

Another point that should be brought out is the fact that the motors are of the remote-control hand-starting type with motor-operated switching equipment, the latter located in a switchhouse near the pit in which the pumps are installed. To start one of these large pumping units,

all that is necessary is to pull a small button-type switch on the switchboard located in the pit with the pumps. The control switchboard in the pit has no higher voltage than 220, while the high-tension wiring that is inclosed in the switchhouse is for 2,300 volts.

The power lines for these two pumping units are three in number, so arranged that each pump has duplicate feeders. Furthermore, these feeders are so arranged that the service can be secured from either one of two large electric power transformers. The power service is furnished at 24,000 volts and is transformed to 2,400 volts by means of two 7,000-kva. transformers connected up on the low-tension side through a double-bus system, so that either transformer can be used independently of the other.

The priming pipes of the main pumps are connected into the suction chambers and piped to an overhead closed vacuum tank. From this tank one pipe is brought down to two vacuum pumps. These pumps are of the Nash rotary type, driven by 220-volt three-phase 60-cycle 5-hp. motors. The vacuum in the tank is maintained at a predetermined point.

### Automatic Vacuum Control

One of the vacuum pumps is started and stopped by an automatic vacuum switch. The vacuum pumps may be started manually in case the vacuum switch fails to function. By means of this system both main pumps are kept automatically primed at all times. This is especially important in view of the fact that in case one pump is operating and suddenly fails to function, the other one can be started quickly, since it is primed and ready for operation.

There is also installed in the pit with the two large

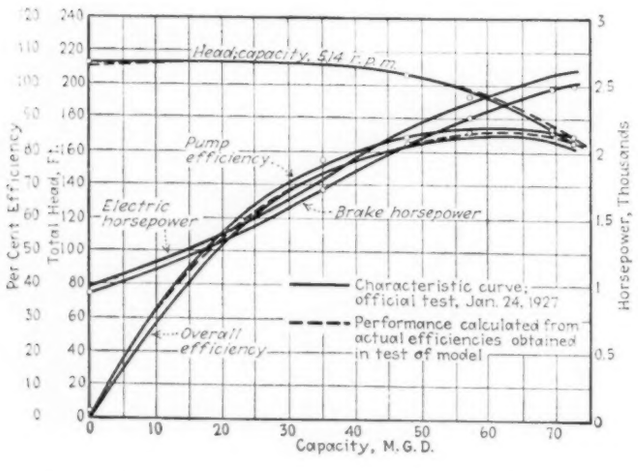



*Fig. 4—Performance of the 70-million gallon pump by test and model prediction*

pumping units, a motor-driven air-wash type of fan to force air up under the motors, air being brought in from the outside or the inside of the pumphouse. The capacity of this fan is 14,000 cu.ft. per minute.

All drainage in the pump pit is carried into a sump in one corner of the pit and pumped to the sewer by an electric-motor-driven centrifugal sump pump.

The auxiliary power service for operation of the vacuum pumps, the fan and the sump pump is taken from the high-tension power lines to the main pump motors and transformed to 220 volts. The transformer for this purpose is in the building that houses the high-tension switching equipment.

In the switchhouse there is another transformer, to transform current from 2,300 to 110 volts for use in the lighting system for the pump pit. This overhead lighting system is one of the interesting features of the installa-

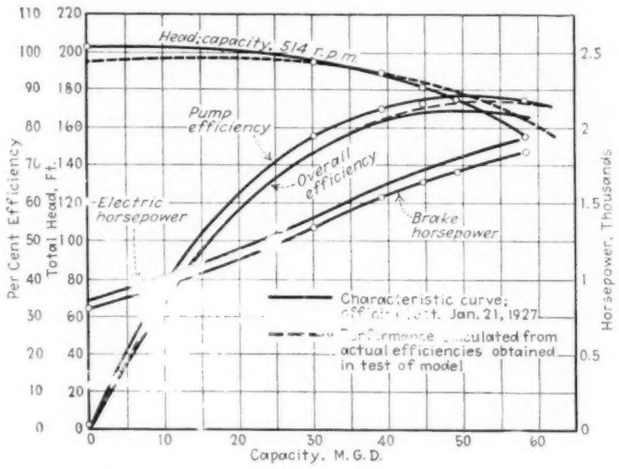



*Fig. 5—Characteristic curves of the 50-million gallon unit*

tion. There are nine 1,000-watt lamps located about the pumps. These lamps give a satisfactory lighting for night-time operation.

## Shaft Governed Steam Valves

MOST modern engines have the point of cutoff varied to suit the load while allowing full pressure in the steam chest. On a majority of high-speed engines some form of shaft governor is used. These governors usually change the valve travel and at the same time the angle of advance is also changed, making admission, cutoff release and compression later.

If the load is reduced, the shaft governor reduces the valve travel and the steam lap is, of course, as before. The angle of advance increases, and as a result cutoff occurs earlier.

It will be noted that the steam lap, as is also the case of the exhaust lap, remains constant at all loads, for the lap does not depend upon the governor, but upon the valve dimensions.

The slide valve found most often with shaft governors is the balanced double-ported type. In this valve steam is admitted to the steam port through the port in the valve and at the edge of the valve. The exhaust steam in the usual design flows by the exhaust edge of the valve and not through the port.

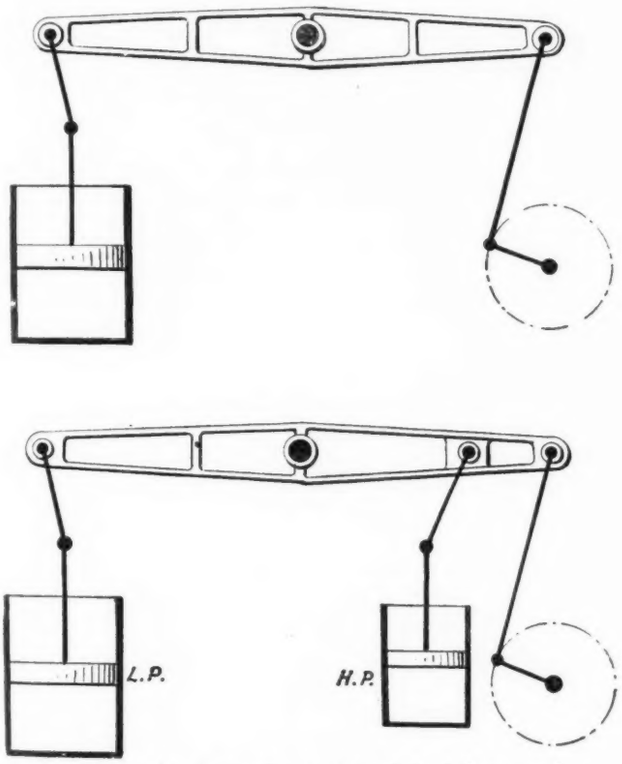
Since the eccentric is fastened to the flywheel, which in turn is keyed to the shaft, the only valve adjustment ordinarily possible is equalizing the lead by adjustment of the valve rod. The first step is to block the governor so the weight arm is in the position it assumes for full-load conditions. A block of wood may be placed between the governor stop on the flywheel and the weight arm. The engine should be turned to crank dead center and the lead measured. Turning the engine on over in the running direction to head-end dead center the head-end lead is measured. If the two are not equal, half the error is taken up by adjusting the rod length.

# McNaughting a Power Plant

By Thomas Roles

City Electrical Engineer and Manager of the Electricity Department, City of Bradford, England

IN THE British papers what seems to be a new term is appearing now and then to describe the method of increasing plant capacity and efficiency by installing a high-pressure turbine unit exhausting through a superheater into the steam header of the existing moderate-




*Watt's simple engine in its original form and after McNaughting*

pressure plant. This is known as "McNaughting" the plant. Readers unfamiliar with the detailed history of the steam engine may be interested to know something of the origin of this term.

Soon after the expiration of Watt's master patent in 1800, the compound engine as devised by Woolf was brought into use, but on account of the high pressure at which it was intended to work, the system was not widely adopted. In 1845, however, W. McNaught patented a method of improving beam engines of the original Watt type by adding a smaller cylinder with a piston acting on the beam between the center and the end to which the connecting rod was attached. Steam of much higher pressure than had formerly been used was employed in the new, or high-pressure, cylinder, from which it was exhausted into the old, or low-pressure, cylinder, where its expansion was completed. This procedure, whereby many old and wasteful engines were converted into useful compound engines, was called "McNaughting" an engine, and it enabled many engines, the power of which was found to be insufficient for the extended machinery they had to drive, not only to exert more power, but to show a marked economy in fuel. The great advantage of McNaught's arrangement is that by opposing the forces developed in the high-pressure and low-pressure cylinders, an increase in power is obtained without increasing the stresses in the beam and framework of the engine.

The arrangement proved so successful that for some years afterward it was actually adopted for new engines, notably by Buckley & Taylor, of Oldham. A modification of the same principle was adopted in the United States by Leavitt, who constructed a number of highly economical water-works pumping engines on this plan, in which the output of the pump represented 84 per cent of the indicated work done by the steam and for some years held the world's record.

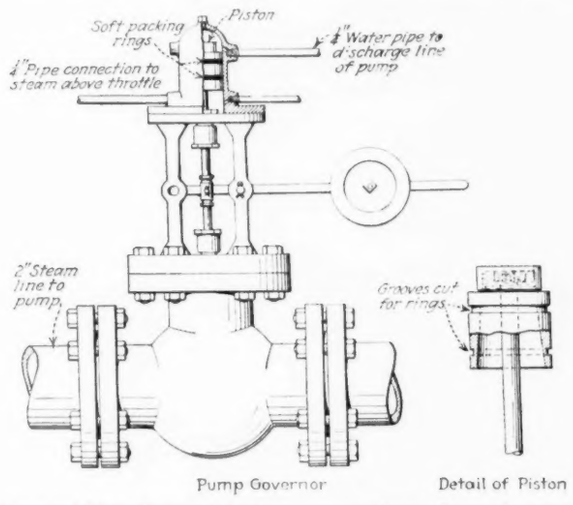
McNaught greatly improved Watt's indicator, substituting the paper drum for the flat reciprocating board, the use of which was possible only on account of the slow speed of the early engines.

The brothers J. & W. McNaught began business in Rochdale, England, as engineers and millwrights in the early part of the last century. They subsequently made wool washing machines as a side line, which, however, ultimately became the most important part of their business. In 1920 they amalgamated with John Petrie, Jr., a rival firm in Rochdale, which had also acquired a great reputation as makers of wool washing machines. Between them the firms have long had an almost world-wide monopoly in their field.

# How Action of Pump Governor Was Improved

By Thomas M. Street

AT ONE of our plants the boiler-feed pumps are equipped with governors of the piston type. The pump discharge pressure is connected above the piston and the steam pressure below. As the pressure varies,


Soft packing rings
Piston
¼" Water pipe to discharge line of pump
¼" Pipe connection to steam above throttle
2" Steam line to pump
Grooves cut for rings
Pump Governor
Detail of Piston

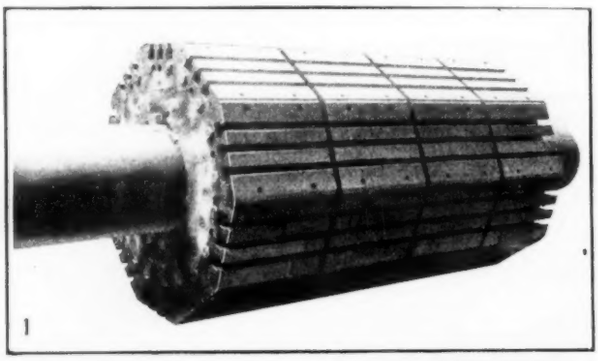
*Soft packing rings added to controlling piston improved operation of governor*

it alters the speed of the pump. The wear on these governors, particularly on the piston, made it necessary to change them every three months, which made quite an expense for repair parts.

The day engineer finally overcame this trouble by cutting two grooves in the pistons and putting in rings of ¼-in. valve-stem packing. One of these governors has been equipped this way for six months and gives much better regulation and a more constant pressure on the line.

# Synchronous Condensers Have Welded Stator Frames

THREE synchronous condensers larger than any now in service are to be used to regulate the voltage of the transmission lines which carry power from the Big Creek hydro-electric development into Los Angeles. The machines, built by the General Electric Co. for the Southern California Edison Co., are each rated at 50,000 kva., and will operate at 13,200 volts, 50 cycles and 600 r.p.m. Each condenser, with its exciter, weighs 375,000 lb., is 26½ ft. long, 16 ft. wide and 12 ft. high. Two



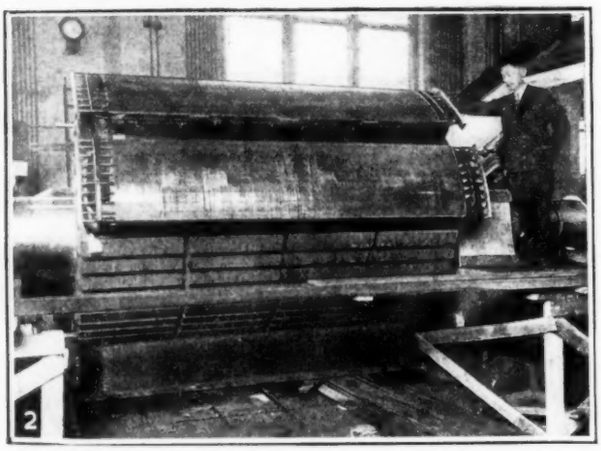


*Fig. 1—Field spider made up of steel plate punchings shrunk onto forged steel shaft*

*Fig. 2—Polepieces held in position by dovetail slots in the spider*

*Fig. 3—Stator frame of electrically welded steel plates*

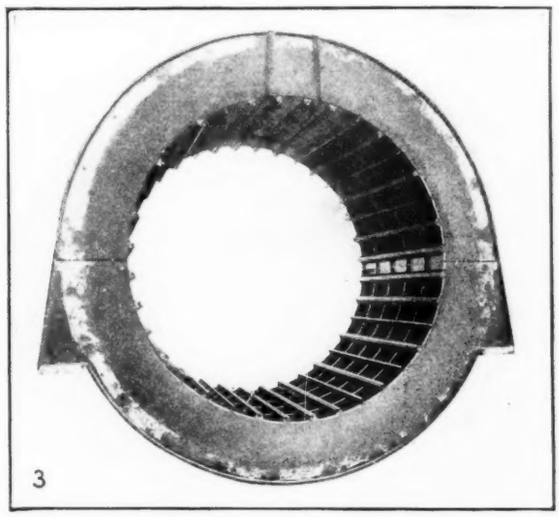
*Fig. 4—Stator punchings assembled in the frame*

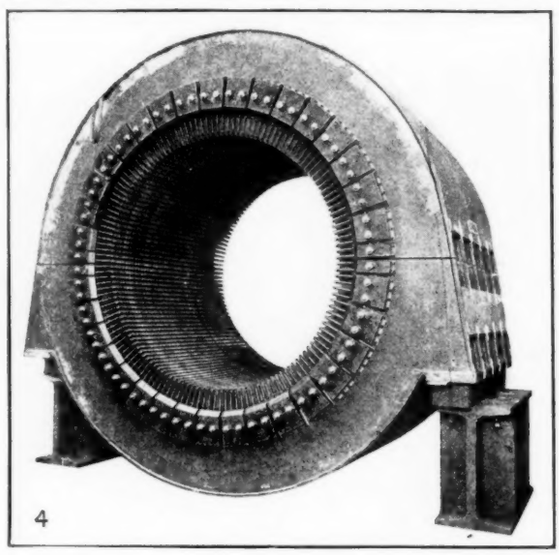
are to be installed in the new Lighthipe substation and the other in the Eagle Rock substation.

The stator frame is of steel plates, electrically welded into a rigid structure and split horizontally to facilitate shipment. The main body is of six annular rings cut from steel plates, with triangular projections to which the feet are welded. A curved plate is welded to the periphery to form the outside cylindrical surface. To the inside periphery are welded rectangular steel bars, slotted to receive the dovetail keys carrying the stator punchings. This type of frame, which has been used for many horizontal- and vertical-shaft machines, has light weight and great strength, is neat in appearance, and, being smooth on the inside, offers little obstruction to the flow of air.

The field spider consists of four sections shrunk onto a heavy forged-steel shaft. Each section is made of laminated-steel plates, with the dovetail slots, the spring pockets and the hole for the shaft made in a punch press. At normal speed each of the ten poles exerts a pull on the rotor of 3,000,000 lb. due to centrifugal force.

Both bearings are of the ball-seat, self-aligning, ring-oiled type, babbitt-lined. Each is provided with a dial-type indicating thermometer, water-cooling coils and pipes





for oil-pressure starting. They are carried by heavy cast-iron pedestals that contain their own reservoirs.

A direct-connected exciter rated at 165 kw., 250 volts, supplies the field current. The magnet frame is of hot-rolled steel; the only castings in it are the armature spider and the support for the brush rigging.

Each of these condensers is to be equipped with surface air coolers, located in the pit beneath the machine. Such a system insures a constant supply of clean, cool air, and lends itself to the use of gaseous fire extinguishers. The blower effect of the rotor is ample to circulate the required amount of cooling air.

## Maintenance of Ash-Handling Equipment

THE Northern States Power Co., Minneapolis, Minn., operates the power plants in the State of Minnesota, where the prime movers are steam-operated and the capacity of each plant exceeds 50,000 kw. The High Bridge plant, with a capacity of 60,000 kw., in St. Paul, is used as a base-load station in an interconnected steam and hydro system and is supplemented by the 72,000-kw. capacity Riverside plant, in Minneapolis.

Eight 18,770 sq.ft. boilers equipped with 14-retort clinker grinder stokers are installed in the High Bridge station. The refuse from the clinker grinder rolls is deposited into ashpits of 30 tons capacity and is cooled by a spray of water. Each pit is equipped with three water-sealed air-operated grates, and the refuse is dumped into standard-gage air-dump cars of 45-cu.yd. capacity or motor trucks. The final disposition of the ash is somewhat indefinite. It is used for the filling of different parts of the yard, repair of the old roads, construction of new roads, and other miscellaneous jobs.

Owing to the variable nature of this disposition, it is difficult to determine accurately the maintenance on the dump cars, locomotive or motor trucks which is chargeable directly to ash handling. Therefore, the only equipment on which maintenance costs are available are the ash gates and pits.

These have been in continuous service for three years, and the main item of maintenance has been that of painting the gates and the air cylinders. There has been, however, some expense caused by the necessity of doing miscellaneous packing jobs. The total cost of maintenance for the period from June 1, 1924, to June 1, 1927, was $301. Of this amount, $270 represents the cost of the cleaning and painting process. During this period 22,000 tons of dry ash, or the equivalent of 30,000 tons of moisture and refuse, was handled. This corresponds to a maintenance cost of one cent per ton of refuse handled.

### Riverside Station

Ten 13,600 sq.ft. boilers are installed in Riverside station, and each is equipped with a 14-retort 17-tuyere, double-dump grate stoker.

Ashpits of 15 tons capacity and equipped with spray lines for quenching the refuse are arranged to receive the ashes from the double-dump grates. The bottom of each pit is provided with a hand-operated gate. Ashes are dumped from these pits into small ash cars and pushed to a large ash hopper 100 ft. distant. This hopper is partly filled with water to complete the process of quenching. A traveling electric crane of 1½-cu.yd. capacity removes the ashes and deposits them into air-dump cars of 30-cu.yd. capacity. The loaded cars are then transported by a steam locomotive to an outside ash hopper 800 ft. away, and are removed by a local contractor. The maintenance cost of the ash-handling equipment from January 1, 1925, to June 1, 1927, was $320. During this period of 29 months, 13,300 tons of dry ash was handled, which is equivalent to about 20,000 tons in the wet condition. This corresponds to a total maintenance cost of 1.6c. per ton.

It might be well to mention that where the apparatus is used for both ash and coal handling, the cost was prorated in proportion to the service. Furthermore, it will be noted that the cost of ash handling in the High Bridge plant for 36 months averaged 1c. per ton of refuse handled, whereas in the Riverside plant for a period of 29 months it averaged 1.6c. per ton. This higher cost was due to the fact that the equipment was ten years old and considerable repair work was found necessary during the period upon which the costs are based.

## Single-Phase Motor Gave Trouble When Starting

By W. L. Stevens

IN MOST cases it probably would not make much difference how a single-phase load was connected on a bank of two transformers, grouped open-delta on a three-phase circuit. There are conditions where it may have a marked effect on the balance of the voltage. Recently, I was called to locate the cause of trouble on a single-phase repulsion induction motor that seemed to have a chronic case of low torque. This motor was rated at 7.5 hp. 220 volts, operated at 1,750 r.p.m. and was connected to two 7.5-kw. transformers grouped in open-delta as in the figures.

These transformers served a load made up of small three-phase induction motors and a three-phase indus-

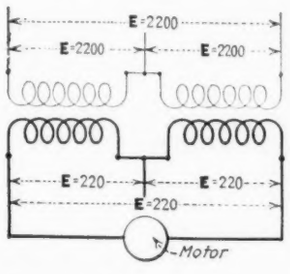



*Fig. 1—How motor was found connected*

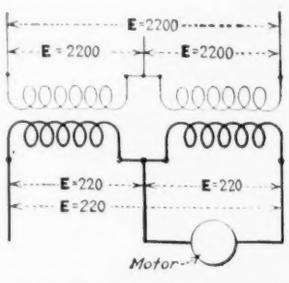



*Fig. 2—Changed connections of the motor*

trial heating load, which, combined with the running current of the single-phase motor, constituted a full load. The line drop was negligible, as the lights, supplied from another transformer connected to one phase of the transmission line, did not give any trouble from flickering. When the motor was started, the voltage would drop from about 220 to 140 volts. This decrease in voltage reduced the torque of the motor to a value where it had difficulty in accelerating the load to rated speed.

Part of the voltage drop could be accounted for in the size of the motor wiring, which was smaller than it should be in good practice. When the motor came up to speed, the voltage increased to near normal. In trying to find the cause of the excessive voltage drop, the motor leads were traced back to the transformer and found to be connected across the two transformers as in Fig. 1. This put the two transformers in series on the single-phase load, consequently the single-phase voltage drop was due to the impedance of the two transformers.

By connecting the motor to one transformer as in Fig. 2, the voltage drop was kept within limits where the motor could start its load satisfactorily. The motor was used only occasionally, otherwise a three-phase unit would have been installed. The owner did not feel justified in buying a new motor when this one was available. A factor that probably added to the difficulty was that the transformers were of different makes and of old designs.

# EDITORIALS

F. R. LOW, *Editor*

## What About the Ford Turbines?

THE leading article in this issue will cause many engineers to speculate on what it has cost the Ford Motor Company to design and build its own steam turbine units. In spite of Mr. Ford's accepted genius for organization it does not appear to be possible for him to have built these units for less than they could have been obtained from any of a number of reputable turbine manufacturers.

An undertaking such as this necessitates the employment of highly expert turbine engineers and designers, as well as the installation of special machine-tool equipment. The resulting high overhead is distributed over a limited number of units, whereas a turbine manufacturer is able to produce and sell a number of units of the same design, thus reducing the overhead chargeable to each unit.

There are several unique features in the design of these turbines whose merits can be determined only through every-day operation for a more or less prolonged period. It is to be hoped that the Ford Motor Company will tell the engineering profession more about these machines from the operating viewpoint. In building units having unusual design features, they are pioneering, but they will have contributed little or nothing to engineering progress until they have made known their experience with these features in actual operation.

Even those who believe the venture economically unjustifiable must agree that Mr. Ford deserves high credit for the courage displayed in entering an unaccustomed field on a large scale.

## Oil Purification

LUBRICATING oil of consistent quality and free from grit, water and other foreign matter, is increasingly important in the satisfactory operation of machinery as speeds go up and machine work becomes more accurate. On the other hand, if oil that has become dirty and unfit for service is discarded, it represents considerable expense. Oil purifying processes using filters or centrifugal separators are becoming common, and may save as much as fifty per cent of the cost of oil when no cleaning is done. If a pressure head is desired in the system, elevated storage tanks may be installed and permanently piped through such purifiers with the necessary pumps. Such a system removes sludge, grit and moisture with little waste of oil, and the oil in the entire system may be completely changed and cleaned every few hours. The necessary makeup supply is added to the cleaned oil in the tanks.

With the high voltages used in power transmission, the purity of transformer and circuit-breaker oil is a vital question. The dielectric strength of insulating oil is greatly lowered by the presence of a small amount of moisture. Although every precaution is taken to prevent moisture entering transformer cases, it is nevertheless necessary to renew the oil periodically. Centrifugal separators are well adapted to removing moisture, and the same oil may be cleaned and used repeatedly with practically no waste. Cleaners may be permanently piped to transformer tanks and connected by opening a few valves, thus permitting one stationary unit to handle the plant. Such installations are common in large central stations.

Circuit-breaker oil becomes carbonized by the arc formed each time the breaker opens. This oil may be cleaned also, and is sometimes piped to the permanently installed cleaners that handle transformer oil. In any plant where either lubricating or insulating oil is a large item, these cleaners will pay for themselves in the oil bill in a short time and maintain the oil at a higher quality. They can be driven from the same power supply as other auxiliaries, and with either intermittent or continuous operation the power used is inconsiderable.

## Wasting One-Tenth

MORE than half a billion dollars, or more than one-tenth of the total of expenditures of local governments in the United States, represents waste and could be saved each year without diminution, either in quality or quantity, of governmental services now rendered, according to the National Industrial Conference Board. The Conference Board gives this figure as its minimum estimate of the amount of the public's money which is dissipated annually through faulty government organization, lack of co-ordination, inefficient budget policies and, in some cases, sheer extravagance.

Somebody, it appears, is wasting our money shamefully. But are we better than they?

How about your power plant and factory, Mr. Reader? You are spending your company's money, lots of it, for fuel and supplies and labor. Are you sure that your

boiler-room efficiency couldn't be raised ten per cent? And do the supplies you buy all go into the service they were bought for, or do the majority of them walk home with your men when the whistle blows? And is the labor you buy and your employer pays for used effectively, or do most of your men sit about much of the time waiting for you to tell them what to do or hiding from you? Do you know?

In the plant, as in government, these are not matters of honesty, but of management. Notice the reasons given above—faulty organization, lack of co-ordination, inefficient budget policies and sheer extravagance. There is no question of outright dishonesty, for the deliberate thief will be caught sooner or later. The big wastes and the wastes that the business man fears more than he fears the crook are those that arise among the men of good intentions and high ideals who are yet a bit negligent or easy-going. Is your plant organization right and tight? Do your men work together? Do you plan your inspection and maintenance work and budget expenses? Do you sanction extravagant methods or equipment?

Remember, Mr. Reader, that you are in charge of some portion of your employer's business equipment and capital. It may be small or it may be large; that distinction need not concern you. What should command your earnest thought is whether you are small or large for your place. It is your responsibility to measure up.

## Why the Variations in Oil Specifications?

THE wide divergence in the requirements of Diesel fuel oil as recommended by the various engine builders calls for comment. From the viewpoints of sales and user's convenience it would be of advantage if the various manufacturers came to an agreement as to what constitutes a desirable fuel oil. It may be claimed that all engines will not operate satisfactory upon a single standard oil. This is undoubtedly true, but the objection can be eliminated by the creation of more than one standard.

There is reason to suspect that the existing differences in oil specifications are due to idiosyncrasies of the builders rather than of the engines. If engine type was the influencing factor, there should be more or less unanimity among those building the two-stroke-cycle and a similar accord in four-stroke-cycle circles. A tabulation of some twenty specifications fails to reveal anything other than discord in both family groups. Even in respect to oil gravity two-stroke-cycle engines apparently can use an oil as low as sixteen Baumé in one instance, while another equally admirable engine needs twenty-six gravity oil in the manufacturer's estimation. Based on such characteristics as coke, sulphur, gravity and acid, apparently the oil seller could find a market for almost any fluid he might have in a tank car.

The great objection to this situation is that when the engine purchaser or potential purchaser enters the oil market with one of these specifications as his guide, he is likely to find that the particular oil cannot be obtained save at a fancy price, while other and equally suitable oils are available at attractive prices. Either the engine builders, large users or oil marketers should start a movement toward the classification of oil specifications.

## Wet Steam in Turbines

IT IS quite generally understood by those who build and test steam turbines that the gain from superheat over the performance with wet steam is proportionately greater than would be indicated by thermodynamic reasons alone. This difference is generally attributed to the added friction losses that occur in a turbine when moisture is present in the steam. Many factors have been offered to correct this moisture effect. As generally stated, these factors provide for a decrease in efficiency ranging from one to two per cent for every increase of one per cent in the moisture content.

The moisture in the steam appears thus to have a braking effect on the turbine due either to increased friction or to pure water-brake action. An expression to cover this effect has recently been developed by a European engineer.

Wet steam also lowers the efficiency of a turbine through actual wear of the vital parts of the machine. Wet steam, flowing at high velocity through nozzles and impinging upon buckets, cuts the metal much as would a sand blast, and the resultant roughening of the surface impairs the efficiency of the machine because steam no longer flows smoothly over the bucket and nozzle surfaces. Once this condition has developed, the only remedy is to replace the eroded parts, and this involves expense for material and labor and holds the machine out of service for a long time. The magnitude of this influence on the efficiency obviously depends upon the severity of the erosion, and, if the machine be allowed to go too long, may develop to serious proportions.

Designing and operating engineers are interested in means that may avoid this loss in efficiency. Higher superheat than now used would move the dew point in the turbine to lower stages and lessen the effect of the wet steam. The use of these higher steam temperatures is imminent. Another plan is to reheat the steam at some point in its expansion, and this is now done in several stations.

Still another plan that has received much study is to devise a method to remove a large portion of the moisture from the steam in the turbine itself by some means of bleeding or drains. Many have tried to effect such a separation. Reports on the actual results obtained are contradictory. The idea warrants still further study, for this appears to be one of the few ways that turbine efficiency may be improved in old plants where lower pressures and temperatures will be used in extensions.

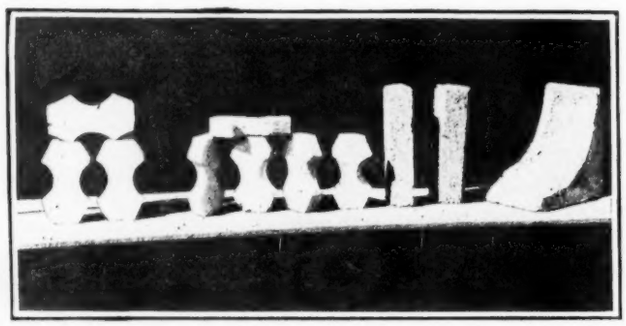
# IDEAS *from* PRACTICAL MEN

*Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted*

## Refractories Made of Crushed Firebrick and Cement

IT IS often said that "Necessity is the Mother of Invention." If this is true, I think it could be said that Chief Engineer Cameron, of the Havana Central Power Station, Havana, Cuba, is the "Father of Invention."

I inspected this plant recently and found that refractory practices had been developed to such an extent that it might be considered as a refinement to the practices



*Molded shapes made of crushed firebrick and cement*

now being used in the larger plants of the United States. At this plant it was not only necessary to secure refractories to take care of the furnaces, walls and boilers, which were being operated at a high rating, but it was always confronted with the necessity of becoming independent of the local market for supplies, as practically all the firebrick refractory shapes had to be imported. This rendered it necessary to develop a refractory that would be suitable for the operating conditions, economical in first cost, low in maintenance and quick to manufacture.

It was found after many tests that discarded firebrick, when crushed and passed through a ¼-in. screen, made a basic refractory material to which a high-temperature cement could be added as a binder to make it of practical use. It developed during these tests that when the crushed aggregate was used, it showed a tendency to be neutral to the operating temperature and was able to withstand much higher temperatures than the brick did in its original form.

A wooden form or mold was built for the shapes desired. Crushed firebrick that would pass a ¼-in. screen, including the fines and a high-temperature cement, was then mixed in the proportion of three parts of crushed material to one part of cement. This mixture was placed in the wooden form and rammed with a blunt-edged tool. When the ramming process was completed, the shape or tile was removed from the wooden form to a dry, warm place, having a temperature of not more than 200 deg. F. Under this condition the moisture in the shape or tile evaporated gradually. This drying out process continued for a period of twelve hours, when they were ready for regular service, no burning or baking being necessary.

Various shapes produced in this way are shown in the illustration. It was found that the cost of manufacturing these shapes was about one-half of what the company had been obliged to pay for standard shapes and that their operation was entirely satisfactory.

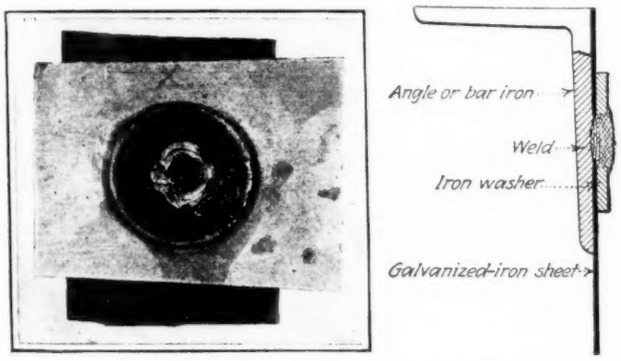
A new and interesting practice was developed in connection with the preventing of the heat from reaching the reinforcing in the concrete floors under the boilers. The investigation showed that the conductivity of the mixture of old crushed firebrick and cement was so low that this insulating problem was solved. This was accomplished by applying 6 in. of the mixture over the air tubes on the floor of the furnace.

Chief Engineer Cameron claims that the savings in cost of manufacture and maintenance of these refractories has far exceeded his expectation.

W. H. GAYLORD, Vice-President,
Quigley Furnace Specialties Co., Inc.
New York City.

## Practical Method of Welding Galvanized Iron Sheet to Steel Angles

The illustration shows a way we have employed to weld galvanized-iron sheets to a frame of steel angles. In using this method it is only necessary to hold the




*Photograph and section showing how galvanized sheet is fastened to angle*

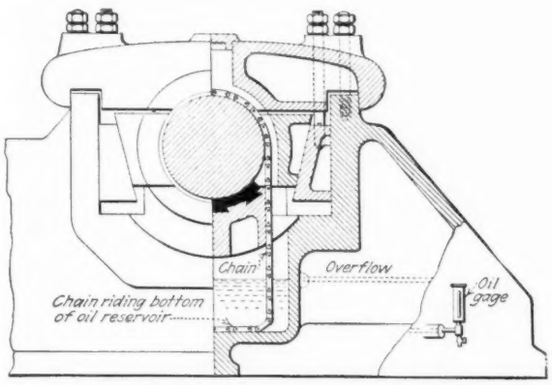
washer in place for an instant, strike the arc on the galvanized sheet, and the sheet is at once firmly welded or buttoned to the frame as shown in the illustration. A 125-ampere arc has been used for this work with good results.

J. C. NUTTER, Supt. of Power,
Groveton, N. H. Groveton Paper Co., Inc.

## Chain Oiler Gives Trouble

A CHAIN oiler on the outboard bearing of our 13x16-in. high-speed Corliss engine had been giving trouble by stopping occasionally. From all appearances the chain, bearing and oil were in good shape and we were at a loss to account for the trouble.

We decided to take out the chain and on examination




*Oil chain rested on bottom of cellar*

discovered a small amount of wear at each link and pin, amounting to enough to allow the chain to lengthen out 4 in. This allowed the chain to ride the bottom of the oil reservoir, as shown in the illustration.

St. Paul, Minn. F. R. STRONG.

## Ground Detectors Necessary on Ungrounded Systems

AS A usual practice in central stations today, a neutral ground on a three-phase, star-connected house-service system is not used, as serious troubles may result in the outside power system if a phase should become grounded in the house-service and necessitate discontinuing this source of power. For this reason also, overload relays are not often used on house generators and transformer banks. However, ground detectors should always be used where a grounded neutral is not employed, in order to protect the insulation and especially to protect any careless workmen who are not expecting a dangerous voltage to ground, should one phase become grounded.

In a central station that used a 2,200-volt, ungrounded-neutral house-service system, the plant consisted of two units for several years. It was contemplated to increase the number in the future, and only the necessary equipment was installed, there being no ground detectors on the station-service bus.

No complications were encountered until two more units were installed and the new electrical equipment was being tested and placed in service. In one week two construction men were sent to the hospital from injuries caused by coming in contact with the live 2,200-volt bus, which at the time was energized by an 11,000- to 2,200-volt station transformer and a house generator. One man had carelessly touched a disconnecting switch while painting around an oil-switch and had been burnt on the feet and a hand to some extent, besides being knocked unconscious. The other had fallen about eight feet after coming in contact with a disconnect.

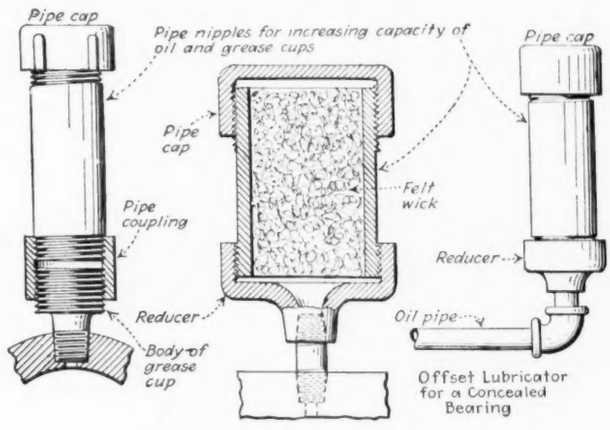
As these men were physically strong, we decided that the phantom voltage to ground of the 2,200-volt system alone would not cause such results, but it was argued that electrostatic induction in the 11,000 to 2,200-volt transformer bank might cause a dangerously high voltage to ground, as the 11,000-volt system used a grounded neutral and the neutral was ungrounded on the 2,200-volt section. This was considered a cause of the trouble until a maintenance electrician was instantly killed by the breaking down of insulation when he touched a taped joint on a motor feeder. It was then decided to investigate and determine the real cause. A potential transformer with a voltmeter across the secondary was used to check the voltage of each phase to ground and, as suspected, two busbars showed 2,200 volts while the other showed nothing. The operating department immediately gave orders to disconnect the new section from the old until the ground had been cleared. It was never thought that the ground might have been on some of the older equipment for several years without anyone knowing it, but when the new busbars were isolated the ground still existed on the old section and was found at one of the old motors. It is needless to say that ground detectors were immediately installed and kept in service —but it was a costly lesson. E. H. STIVENDER.

Los Angeles, Calif.

## Improvised Oil and Grease Cups from Pipe Parts

SOME equipment in power plants has only a limited number of oiling and greasing plugs. The engineer has the daily task of going over the lubrication devices of a machine to insure that it will give service. To provide an oil plug of large capacity, it is possible to make an extension of a small pipe coupling and nipple, thus insuring ample lubrication. An excellent large grease cup can be made from a nipple, reducer, large nipple and a pipe cap.

Another form of oiler is shown in the illustration along




*Home-made oil and grease cups*

with those just described, consisting of an oil pipe connecting to an ell, to which a reducer and oil reservoir of larger diameter are attached. The engineer of one large shop in which much time had been lost due to machine trouble, used these means to increase the lubricating facilities of the machines and to add oiling facilities where none was previously provided. The oil pipes were fitted with felt wicks for continuous feed. Many pieces of machinery can be improved through the adoption of these means. G. A. LUERS.

Washington, D. C.

# COMMENTS *from* READERS

## *Unbalanced Fans*

READING the article by James F. Hobart in the July 5 issue, brings to mind an experience I had with some high-speed forced-draft fans installed under underfeed stokers.

The fanroom was in the basement and somewhat open to the ash alley, as the plant was being remodeled. As the fans were new, some of the operators were overanxious to give the bearings plenty of oil and some of this oil ran out along the shaft and into the fan-rotor blades. When the ash hoppers were emptied, a certain amount of dust was drawn into the fan rotor and mixing with the oil, added considerable uneven weight on the blades. This threw the fan rotor out of balance.

When the dividing wall between the fanroom and ash alley was finished and the operators were instructed as to the proper oil level to carry, the trouble ceased.

Swansea, Mass. ALLEN L. DONOVAN.

* * * *

## *Does the Oil Film Burn?*

IN THE June 21 issue of *Power* was printed a comment of L. C. Price regarding the lubricating-oil film on the cylinder walls of an oil engine, in which he questioned the accuracy of the statement made in the "What Do You Know" column that during the power stroke the film is burned and the walls left dry. An editorial comment at the end of the discussion indorsed the original contention.

Suppose the same thing were true for a gasoline engine

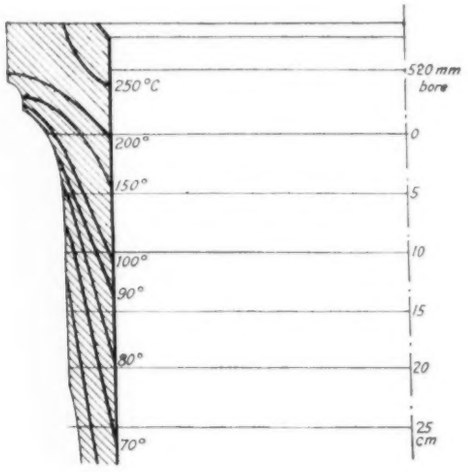



*Fig. 1—Temperatures found in Sulzer tests*

in which the gas temperatures as a rule are not lower than those of an oil engine. Let us assume that the complete oil film of the exposed cylinder wall burns during the power stroke, while the gas temperature varies from 3,500 deg. F. to 1,500 deg. F., leaving the cylinder wall completely dry after each stroke. If we consider an oil film only 0.001 in. thick, a 3x5-in. six-cylinder engine running at 3,000 r.p.m. would consume 42.5 cu.in. of oil in every minute, and we should be compelled to refill the crankcase with six quarts of oil every ten miles.

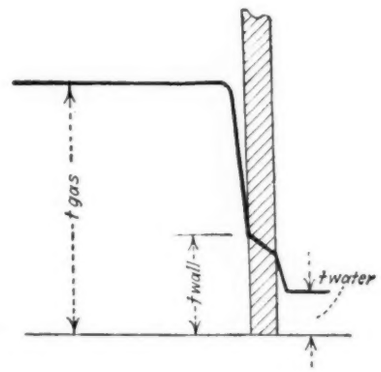



*Fig. 2—Temperature gradient in a cylinder*

This of course is absurd, and the actual oil consumption is less than one hundredth of this amount.

The explanation of the thing, it seems to me, is that the temperature of the oil film is far from the temperature of the burning gases; in fact, it is much closer to the cooling-water temperature. According to the measurements of Gebr. Sulzer, the temperature distribution in the cylinder, wall and water pocket of a two-stroke-cycle oil engine is similar to Fig. 1, which shows that the greatest temperature drop is in the "gas skin" close to the cylinder wall. The temperatures on the cylinder wall are similar to Fig. 2, and they are subjected to little fluctuation during the cycle. It will be noted that the wall temperatures are lower than the flash points of most lubricating oils, therefore very little oil will burn on the cylinder walls. Oil that gets on the cylinder walls about the combustion space or on the cylinder head will burn, of course. P. H. SCHWEITZER,

Assoc. Prof. of Engineering Research.

State College, Pa.

[In the Sulzer tests mentioned it was found that the temperature of the inner wall was far above that of the cooling water, being in the neighborhood of 750 deg. F., as is shown in Fig. 3, a reproduction from one of the Sulzer charts which appeared in *Power*, Sept. 21, 1926. This temperature is close to, if not above, the boiling point of most lubricating oils. With this temperature below the oil film and a combustion temperature of, say, 2,500 deg. above it, most of the film must burn. In the original "What Do You Know" answer it was not intended to apply to that portion of the walls protected by the piston from the high gas temperature.

In addition, calculations based on an assumed thickness of the film cannot logically be used to prove the impossibility of burning. After the close-fitting ring sweeps over the oil, it is questionable if the thickness of the

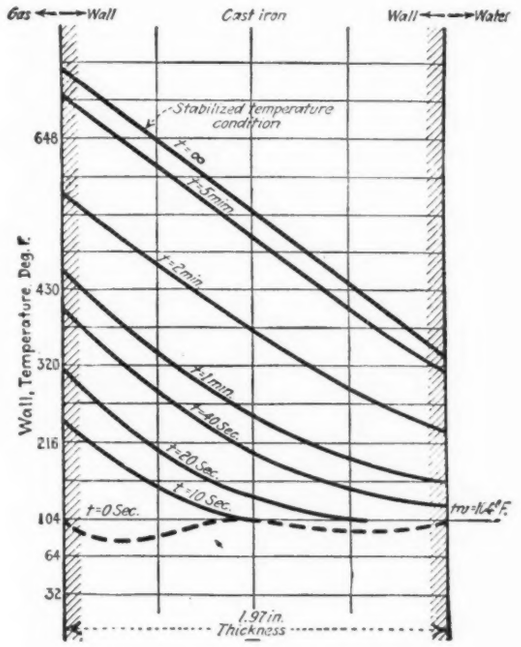



*Fig. 3—Wall temperatures found in the Sulzer tests*

film is anywhere near 0.001 in. If the film does not burn, why is it necessary to feed oil to the internal-combustion engine cylinder at a rate far above that needed in a steam engine?—Editor.]

* * * *

## *The Engineering Student and The Job*

THE July 19 issue of *Power* has just come to my attention, and I wish to endorse and thank you for the keen and inspiring Foreword on "The Engineering Student and the Job." As a student at the foremost technical college in the country I have come into first-hand contact with the problem of engineering education.

Despite the value of the courses taught, the demand for graduates and the encouragement of executives and others in industry, the enrollment of our school has since the close of the war boom dropped off steadily year after year. In my opinion the fault lies with the prospective students. Most of them would rather enter an arts college where no entrance examinations are required, the work is reduced to a minimum, and the greater part of their time can be spent at sports and entertainments. It is up to the executives, practicing engineers, and especially technical journals like *Power*, to impress upon high-school graduates and their parents and friends the advantages of studying technical courses and the pressing need for engineers today and the growing demand for them in the future. They should assist the colleges to make their engineering courses attractive and otherwise help them to provide technical graduates in ample quantity and with the correct requirements for the positions open to them.

It would be a great thing if *Power* could continue to encourage the attack and solution of this problem.

Erie, Pa. DONALD MCC. STURZNICKLE.

## *Preventing Sight-Feed Glass from Attracting Oil*

WHILE reading the practical letter in the July 12 issue on "Preventing Sight-Feed Glass from Attracting Oil," it occurred to me that *Power* readers might be interested to know of a simpler way of doing this.

After cleaning the sight-feed glass, fill it with clean water through the plug hole at the top, then add a pinch of salt and, still more important, never let the lubricator run entirely empty before refilling. By following these directions, I have never had any trouble from the glass attracting the oil. A. PULLEKINS.

Akron, Ohio.

* * * *

## *Others Do Not—They Do Not*

HAVING had several years' experience in plants in the southern part of New Jersey, I am familiar with operating conditions in the vicinity of Parlin. I have followed the discussion between Mr. Nixon and Henry James with profound interest. The latter is to be congratulated upon his courage and sincerity.

In one of the plants I have had experience in, the power superintendent believed that the only way to save money was not to spend it. He frequently stated that he was saving the management $25,000 a year. An investigation was undertaken when partial breakdowns became an hourly occurrence and complete shutdowns a weekly matter. It was found that the power-house records showed a weekly coal consumption of 610 to 650 tons and an accumulation of coal on hand exceeding 32,000 tons. After checking the matter, it was found that the weekly coal consumption was between 1,200 and 1,500 tons and that the coal on hand was less than 19,000 tons. Only after "firing" the power superintendent and installing improvements at the expense of over $1,000,000, did the management succeed in reducing the coal consumption to an average of 850 tons a week and the shutdowns to a negligible amount.

In another plant the power superintendent frequently boasted of operating the power house at an efficiency of 80 per cent. When I attempted to check some of the items on record, I found the combustible in the boiler refuse to exceed 40 per cent and the flue temperature of some of the boilers was almost 900 deg. F. A veteran employee in the plant told me that there has never been an honest test or record made. The "consulting engineer" demanded results with an equipment that was 75 per cent makeshift and 90 per cent obsolete. He was given "results" on paper, and everybody, apparently, was happy.

Mr. Nixon's statement, "We have no men in our local organization who feel that they are power experts," etc., is illuminating and explains the entire matter.

That he has some good average men in his employ is indeed a case of exceptional luck. Not so long ago, a Parlin plant was looking for an "assistant master mechanic to take charge of a construction and maintenance force of 100 mechanics, good executive, designer, purchaser, etc., at a salary of $150 per month, to start."

That "ideal water" has been found in South Jersey is another lucky strike. The news of it will instill a ray of hope in the hearts of some South Jersey plant operators who frequently have to battle with water containing 60 to 80 grains of solids per gallon.

New York City. E. OGUR.

## *Unscrewing Rusty Threads*

IN THE July 5 issue there appeared an article by James F. Hobart on unscrewing rusty threads, which was very interesting, as I used to have the same idea. However, I heard of a different plan one day and tried it with success.

I was told to get a cake of paraffin wax, such as is used by housewives to seal jelly glasses, and while the line or fitting was hot, to press the cake on the nuts or fitting and let the melting paraffin run down on the threads. Do this once or twice if possible some time before the work is to be done and you will be surprised with the results.

This has been used on joints to superheated steam lines with success.

GEORGE A. DAIRS.

Philadelphia, Pa.

* * * *

## *Insulated Rotor Bars of Squirrel-Cage Motors*

THE article, "What Made the Motor Howl?" by C. Dickerson, in the May 31 issue, brings up an interesting question. This article referred to an alternating-current elevator motor in which the rotor insulation had presumably disintegrated, allowing the rotor winding to vibrate in the slot.

For years it was the practice to insulate the rotor winding on squirrel-cage motors because of the supposedly better performance. The question of quietness of operation was never a factor. It was always a question of improved performance or reduced temperature rises. Insulating squirrel-cage windings so that they would stand up under all conditions of service was no easy problem and led to the use of bare rotor bars, driven tight into the slots, and dispensing with the insulation.

Elaborate tests were made on motors using the uninsulated bars, and in the vast majority of commercial sizes the reduction in performance or increase in temperature was so small as to be considered negligible. The improvement in mechanical construction and reduction in maintenance so far outweighed any slight disadvantage in performance as to make it no longer desirable to insulate the rotor windings of standard commercial squirrel-cage motors.

It was found that certain high-speed ratings (motors with low number of poles) on the larger sizes showed marked reduction in performance with a corresponding increase in rotor temperature. With such motors an improved insulation for the rotor bars has been devised and is used by the Westinghouse company. On the smaller sizes of high-speed ratings aluminum cast rotor windings are used. Aluminum, when exposed to the air, has a happy faculty of forming an oxide coat which serves as an insulator. Thus, it is seen that the old-fashioned paper insulated bar is no longer necessary.

In the article under discussion it was claimed that when the bars of a rotor are grounded, the motor is noisy when changing from one speed to the other, but becomes quiet when new rotor slot cells are inserted. Our experience would lead to the following conclusions:

A. Since the bars were originally insulated, the slot had to be large enough to admit both bar and cell insulation. Consequently, if wedges were inserted on top of the bars, there would still be space between the sides of the bars and the walls of the slot. In other words, the bare bars would still be loose in the slots.

B. In changing from one speed to another, there is a sudden and corresponding change in torque, which causes the rotor bars to react against the sides of the rotor slots. In other words, vibration is set up between the sides of the bars and sides of the slots, which dies down as soon as the change in speed is consummated and returns as soon as another pole connection or speed change is made.

C. By removing the rotor winding and re-insulating the bars on all sides, the space between the bars and the sides of the slots was considerably decreased. What little mechanical movement still took place was cushioned by the insulation. Obviously, this reduced the vibration and noise.

D. Driving the wedges on top of the bars, as was done first with the old insulation in the slots, did not produce sufficient friction to prevent the bars from vibrating. Insulating the bars all around reduced the vibration enough to kill the noise, and since it satisfied the ground test for insulation, made Mr. Dickerson believe that the noise was killed by virtue of rotor-bar electrical insulation.

The practice of today on squirrel-cage elevator motors is to drive the rotor bars tightly into the slots without insulation so as to prevent tooth-and-bar vibration, and rely on proper selection of primary and secondary slot combinations to produce a minimum of magnetic vibration. With the heat that is generated in a 20-hp. elevator high-slip rotor, it is quite possible for the rotor insulation to deteriorate, in which case the rotor winding will again become loose and will require re-insulation in time to overcome objectionable noise.

G. J. SCHMIDT, *Motor Engineering,*
Westinghouse Electric & Mfg. Co.

East Pittsburgh, Pa.

* * * *

## *Transatlantic Flights*

I SHOULD like to add a postscript to the interesting letter by E. J. Jordan on "Transatlantic Flights." in the July 19 issue. Mr. Jordan also has unwittingly made a little slip. It was Hawker, not Hawkins, who, attempting the first "hop" from Newfoundland to Ireland, found his lubricating system out of order and "landed" in the sea near a sailing ship.

Indeed, as Mr. Jordan says, Hawker was not less daring than those others who followed, but what about our young naval officers who, preceding Hawker, flew their naval planes from Newfoundland for the Azores, and one of which, the NC4, did succeed in this perilous attempt and proceeded on to Lisbon and thence to Plymouth, England, thus completing the first flight in history across the Atlantic. Engineer Officer Breese, of the NC4, told me they had one quart of gasoline in the tanks when they reached the Azores.

I had the honor of attending the testimonial dinner to Colonel Lindbergh at the Hotel Savoy, London, on June 2 and hearing his modest address. He also, perhaps for diplomatic reasons, gave Alcock & Brown credit for the first transatlantic flight.

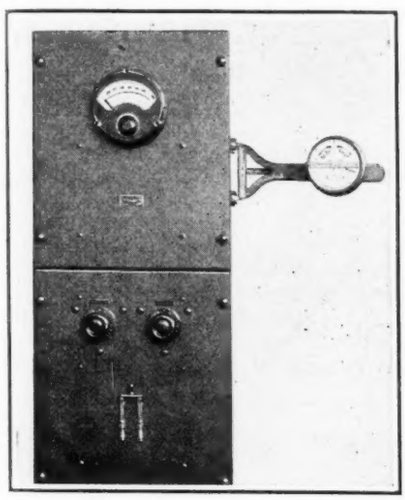
Paraphrasing Mr. Jordan's closing remarks, I wish to say that I hope that Lindbergh and Chamberlin and Byrd will not in eight years be so utterly forgotten as the NC4 and her gallant crew appear to be.

New York City. ERNEST H. PEABODY.

# *New and Improved* EQUIPMENT

## Vacuum-Tube Synchronizer Uses Radio Tubes

Vacuum tubes, developed primarily in the field of radio, have now been applied in an entirely different field—that of a vacuum-tube synchroscope for indicating whether electric generating machines are properly timed in their operation. The apparatus, shown in the figure, gives a direct indication of whether incoming machines are running too fast or too slow and shows the difference in speed without any time lag. The first installation of this new type of equipment was made by the General Electric Company at the Menands substation of the Adirondack Power & Light Corporation, near Albany, N. Y.



*Amplifier panel for vacuum-tube operated synchroscope.*

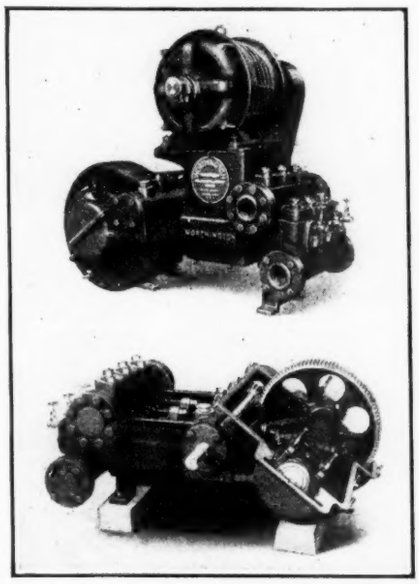
The vacuum-tube synchronizing equipment provides the usual "fast," "slow" and "synchronism" indications without the use of instrument potential transformers. Potential from the lines to be synchronized is obtained from a capacitance transformer and is amplified by means of vacuum tubes until sufficient power is obtained to operate a synchroscope.

Standard oil-filled bushings of transformers, oil circuit breakers or other apparatus can be replaced by a modified bushing with capacitance transformer for furnishing potential to the vacuum-tube apparatus. Where such bushings are not in use, the capacitance transformer can be supplied in a separate tank which can be installed either outdoors or indoors. The voltage obtained in this way is in phase with the line-to-neutral voltage of the system. A capacitance transformer must be provided at each point where a potential transformer would be necessary if transformers were used for synchronizing. The potential obtained from the capacitance transformer is impressed on the grid-filament circuit of a vacuum tube and amplified.

The station equipment consists of a tube and control unit, a motor-generator set and the synchroscope. The tube and control unit consists of two 50-watt amplifying tubes and their associated equipment. These tubes will amplify the energy received from the low-power amplifiers sufficiently to operate the indicating synchroscope. The high-power amplifying equipment will take care of any number of synchronizing points at one substation. Proper switching means are provided to take care of a number of circuits where this is necessary.

## Worthington Enclosed Horizontal Triplex Power Pump

The illustration shows a type of single-acting triplex power pump recently brought out by the Worthington Pump & Machinery Corporation, New York City.



*Pump equipped with motor drive and with crankcase cover removed.*

The pump is of the outside-packed plunger type and is being made in two sizes: 2¾x5 in. and 3½x5 in. It is designed to operate at 200 r.p.m. crankshaft speed, which gives the smaller pump a displacement of 77.5 gal. per min. against a pressure of 500 lb. The larger unit will displace 108 gal. per min. against a pressure of 360 lb. The gear ratio is 6 to 1, hence the pinion shaft may be direct-connected to a 1,200-r.p.m. motor or engine.

The enclosed crankcase provides a large oil reservoir for the flood lubricating system. The rim of the main gear runs submerged in the lubricant and carries oil to the top of the crankcase, whence it is distributed to all bearings.

The fluid end of the pump is cast integral with the frame, with all valves separately accessible from above through individual handhole covers. The cylinder is of steeline, of the single-casting type. The valve chest is cast integral with the cylinder. Suction and discharge openings are cast with the chest, and are of the flange type. The valves are of the bronze-wing-guided type with heavy bronze seats driven into the deck on a taper.

## Alternating- and Direct-current Solenoids

A new line of solenoids now on the market, by the General Electric Co., includes both alternating- and direct-current types and has been designed especially for uniformity and flexibility. These are made for all standard frequencies at voltages up to and including 550 volts and with few exceptions differ in size only.

Each size of solenoid has four types made up with the same frame, allowing it to be adapted to a variety of applications. An a.c. model can be used for d.c. operation by simply changing coils and adding a cutout switch for which all frames are drilled. A pulling solenoid may be changed to the pushing type by adding two standard pusher bars. The pole face of the plunger is cylindrical and fits into a cylindrical seat on the frame, thus insuring quiet operation in any position.

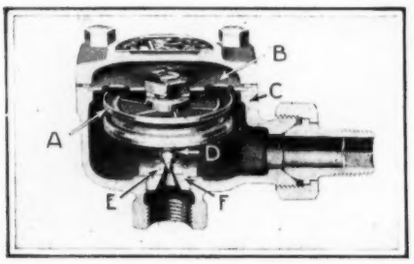
In addition to the usual switch and relay operating service these solenoids have a variety of applications including the following: Tripping mechanisms such as brakes and toggles; clutch-operating mechanisms; safety appliances and signal operation; stereopticon machines in which the solenoid changes the slides; operation of small valves on household appliances; bell ringing by means of solenoid chime operation; and various applications of the same general character.

## Webster Series 78 Thermostatic Traps

A new line of thermostatic traps designed especially for use with process steam using equipment with pressures ranging up to 100 lb. has recently been introduced by Warren Webster Co., Camden, N. J.

Referring to the illustration, which shows a cut-away view of the trap, the expansion member *A* is made of monel metal and held in position by a circular brass plate *B* which rests in a recess in the trap body *C*. A distance nut separates the circular plate and expansion member and permits free circulation of the steam around the diaphragm. The cone-shaped valve *D*, which is made of stainless steel, closes against a square-edged seat *E* of the same metal set in a brass bush *F* with hexagon head and expanded opening. The cover and body *C* of the trap are of brass.

The new line is made in the angle




*Cut-away view of thermostatic trap*

pattern only and in ½-, ¾- and 1-in. sizes and two pressure classes. No. 2 class is adaptable to pressures up to 50 lb. and No. 3 class to pressures from 50 to 100 pounds.

## Conner Automatic Ammonia Purger

An automatic return and the use of perforated baffle plates to prevent the foul gases present within the purger from settling to the lower portion of the system, are the outstanding features of the automatic ammonia purger recently developed by the Conner Purger Co., 30 Church St., New York City.

Referring to the illustrations which show a typical installation and cross-section of the unit, the purger is mounted above the receiver and connected as shown in Fig. 2.

With the plant in operation the air and non-condensable gases which collect in the receivers pass to the purger through the connection *A*. Then, when liquid ammonia is admitted to the closed coil *B* within the purger through the expansion valve, a temperature much below the condensing point of ammonia at the existing pressure is maintained. This causes the ammonia gas within the purger to be condensed, and the liquid returns automatically to the receiver through the same pipe connection *A*.

As the connection to the purger is at the bottom, the movement of the gases is upward within the purger, and as the heavy non-condensable gases are prevented from settling to the bottom by the

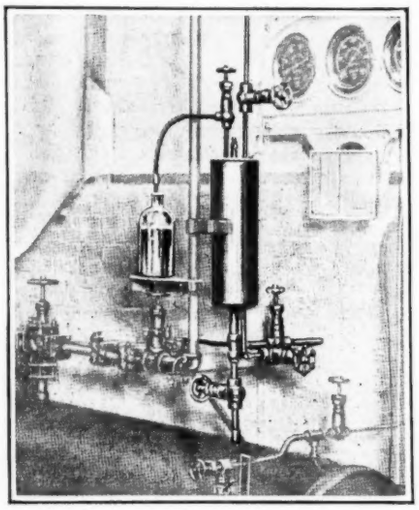


*Fig. 1—Typical installation of purger*

perforated baffle plates *C*, previously referred to, they are trapped at the top of the purger and pass through the connection *D*, the end of which is submerged in a glass jar filled with water.

As the purger is designed for continuous operation, the visibility of the

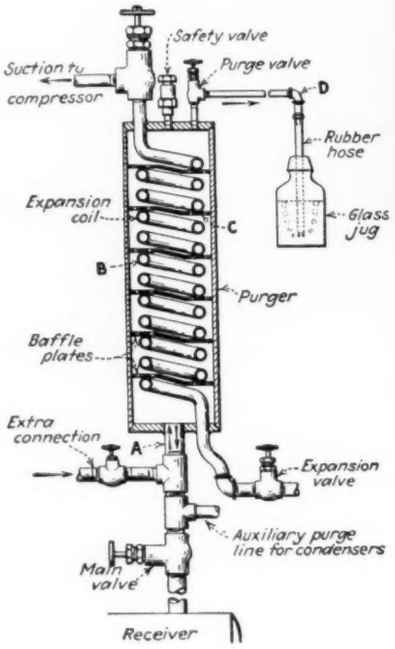



*Fig. 2—Cross-section of purger*

gas discharge obtained through the use of the glass jar is important. The air and non-condensable gases pass up through the water in the jar in the form of bubbles, and the presence of ammonia gas is indicated by collapsing of the bubbles. This feature makes it possible to set the purge valve to discharge the foul gases at about the rate at which they collect in the system, instead of operating the purger intermittently at a higher rate, as is the usual practice. In installations where an auxiliary purge line is run to the condensers, the purger tends to improve the circulation within the condensers and to overcome the tendency of the ammonia to lie dormant in some of the coils.

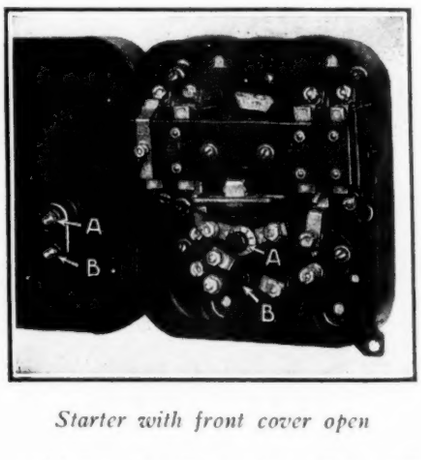
The purger is made in two sizes, the standard size for plants of large capacity and the No. 2 purger for small plants.

Among the important claims made for this purger by the manufacturer are continuous purging without manual manipulation of valves and lowered power costs and ammonia consumption.

## Cutler-Hammer Small Across-The-Line Starter

A small across-the-line starter for motors of 5 hp. and under, recently announced by the Cutler-Hammer Manufacturing Co., Chicago, gives push-button control of starting and stopping and provides thermal-overload and no-voltage protection.

The starter is provided with push buttons *A* and *B* in the front cover of the case, which is shown in the open




*Starter with front cover open*

position on the illustration. The small size, in most cases, permits mounting of the starter where the control station would ordinarily be placed, and the extra wiring and cost of a push-button station is thus saved.

An important feature of the starter is the type of contactor used. A roller is forced between two fingers to complete the circuit. Thus a double break and a wiping contact are secured. This arrangement, it is claimed, reduces arcing to a negligible amount.

To adapt the starter for any horsepower within rating, it is only necessary to insert the proper-sized heater coils in the thermal overload relay.

In addition to the usual starting and stopping service the starter is available to machinery builders without the case, for incorporation in machinery design as standard equipment.

# Higher Steam Pressures and Temperatures*

By Thomas Roles

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IN CONSIDERING the economy which theoretically may result from the use of higher steam pressures, a reference to the temperature-entropy diagrams (Figs. 1 and 2) will be useful. These diagrams have been prepared from figures obtained from "The Enlarged Calendar Steam Tables" and are based on steam at 800 deg. F. and a vacuum of 28 in.

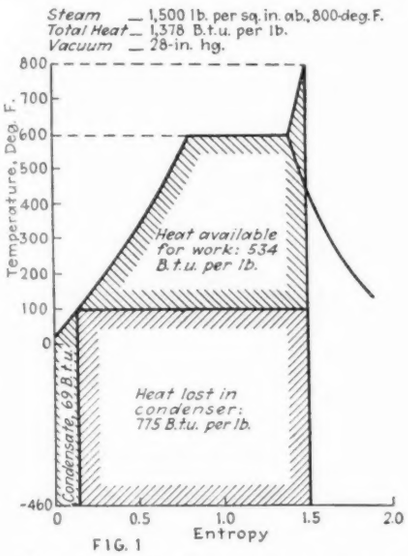

Steam — 1,500 lb. per sq.in. ab., 800-deg. F.
Total Heat — 1,378 B.t.u. per lb.
Vacuum — 28-in. hg.
Temperature, Deg. F.
Heat available for work: 534 B.t.u. per lb.
Heat lost in condenser: 775 B.t.u. per lb.
Condensate, 69 B.t.u.
Entropy

FIG. 1

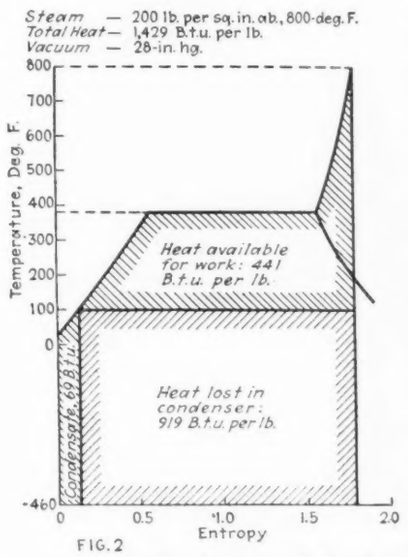

Steam — 200 lb. per sq.in. ab., 800-deg. F.
Total Heat — 1,429 B.t.u. per lb.
Vacuum — 28-in. hg.
Temperature, Deg. F.
Heat available for work: 441 B.t.u. per lb.
Heat lost in condenser: 919 B.t.u. per lb.
Condensate, 69 B.t.u.
Entropy

FIG. 2

*Figs. 1 and 2—Temperature-entropy diagrams comparing heat available for work with steam at 1,500 and 200 lb. per sq.in.*

The diagrams indicate that at the higher pressure the total heat in one pound of steam is 3.57 per cent less than at the lower pressure; but, on the other hand, the heat available for work is 21 per cent greater. Putting the matter in another way, it can be said that in the utilization of a British thermal unit in steam at 1,500 lb. 26 per cent more work is performed than in its utilization at 200 lb. Incidentally, the diagrams are interesting as showing the large proportion of heat rejected to the condenser compared with the heat available for work, and it is for the purpose of still further reducing the amount of heat rejected to the condenser that regenerative feed heating has been developed during late years.

The full-line curves in Fig. 3 show the theoretical steam and heat consumptions per kilowatt-hour at various initial steam pressures between 200 and 2,000 lb. per sq.in. absolute, when working with a vacuum of 28 in. and temperatures of 700, 800 and 900 deg. F. The curves given in dotted lines show such consumptions at the various pressures when the steam temperature is 800 deg. F. and the vacuum 29 in. These curves clearly indicate the increases in efficiency that may be obtained as steam pressures and temperatures are raised.

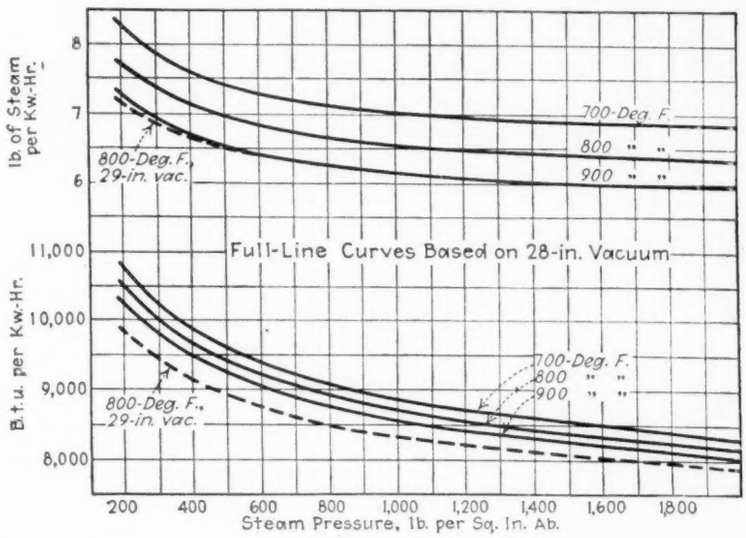



*Fig. 3—Effect of steam pressure on theoretical steam and heat consumption*

From the curves in Fig. 3 a further diagram (Fig. 4) has been produced illustrating the percentage rate of decrease in heat consumption with steam at various pressures from 200 to 1,600 lb. per sq.in. absolute, superheated to a total temperature of 800 deg. F. It will be noticed that the percentage decrease is slightly higher when the steam is expanded to 28 in. vacuum than when expanded to 29 in., from which it follows that the adoption of higher steam pressures is even more advantageous to stations running under cooling-tower conditions than to those where ample supplies of cold water are available. It is also apparent that a considerable gain in efficiency is effected from each 100 lb. per sq.in. increase in steam pressure between 200 and 600 lb.; that a considerable further increase in efficiency is obtained by increasing the pressure from 600 to 800 lb. per sq.in.; but that from 800 lb. upward the increase in efficiency is more gradual.

It must be noted that all the foregoing figures regarding increase in efficiency consequent upon the adoption of higher steam pressures are theoretical and that the actual gains must of necessity be less than those shown. In practice theoretical values can never be realized. The losses are, however, somewhat different in magnitude in high-pressure plants and low-pressure plants.

In the present state of the art of tur-

*Excerpt from paper before the Incorporated Municipal Electrical Association at Buxton, England, May 30 to June 4, 1927.

bine design it is not possible in a turbine built for a high pressure to abstract work from the expansion of the steam so efficiently as can be done in a turbine constructed for a lower initial steam pressure. High-pressure turbines have to deal with steam of much greater density than normal pressure machines, consequently blade windage and disk friction must be greater. It follows that the steam guide passages and blade heights must be of smaller dimensions and the clearance spaces of greater relative proportion, and, therefore, leakage loss due to clearance will be increased.

In order to obtain the highest possible turbine efficiency and, incidentally, to prevent the erosion of blades at the low-pressure end of the turbine due to wet steam, it is desirable, as the initial pressure is increased, also to increase the superheat and consequently the total temperature. A limit, however, is soon reached beyond which such increases in temperature becomes prohibitive by reason of the reduction in the strength at high temperatures of metals of which

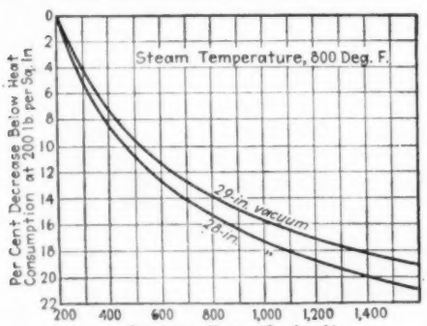

Steam Temperature, 800 Deg. F.
29-in. vacuum
28-in. "
Per Cent Decrease Below Heat Consumption at 200 lb. per Sq. In.
Pressure, lb. per Sq. In. Ab.

*Fig. 4—Theoretical decrease in heat consumption through increased pressure*

the superheater, turbine and auxiliaries are built. This difficulty can be overcome to some extent by adopting an intial temperature for the steam such as is known to be safe having regard to the metals which are used, and by extracting the steam after it has passed through a certain number of the turbine stages and reheating it to its initial temperature prior to its being returned to the turbine for expansion in the remaining stages.

With regard to the condensing plant, it has been shown in the diagrams, Figs. 1 and 2, that less heat is rejected to the condenser by high-pressure turbines than by turbines of similar capacity working at normal pressures, and such being the case, the condensers of high-pressure turbines may have less cooling surface and will require less circulating water for the condensation of the steam. It follows, therefore, that the size of the circulating water pumps and piping is also less, and the same applies to the capacity of the artificial cooling-water plant where such is in use. These matters, while affecting the capital cost of the condensing plant and the power required for its operation, do not, of course, have any bearing on the question of the condenser efficiency, and it will be clear that a condenser for use in conjunction with a high-pressure plant should be quite as efficient as one for use with a normal pressure plant.

The figure of 26 per cent, previously quoted as the theoretical advantage de-

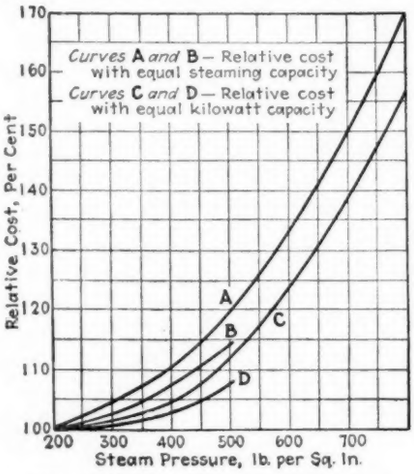

Curves A and B — Relative cost with equal steaming capacity
Curves C and D — Relative cost with equal kilowatt capacity
Relative Cost, Per Cent
Steam Pressure, lb. per Sq. In.

*Fig. 5—Relative cost of boilers for various pressures*

rived from working at a steam pressure of 1,500 lb. per sq.in. in comparison with a pressure of 200 lb. does not take into consideration boiler efficiency, by reason of the fact that such figure is based on the heat content in steam and not in fuel.

With high steam pressure plants the feed pumps require considerably greater power for their operation than pumps dealing with equal quantities of water in connection with normal pressure boilers, as with constant feed-pump efficiency the power required varies directly as the pressure. It is, however, not possible, at present at any rate, to obtain pumps for high-pressure working equal in efficiency to those suitable for operating at normal pressures.

The effect of pressure on the efficiency of the remainder of the boiler auxiliaries, such as the forced-and induced-draft fans, etc., is practically negligible. On the whole, therefore, it may be said that the efficiency of a high-pressure boiler plant should be but little below that of one equipped for working at a normal pressure.

It has been shown by the temperature-entropy diagrams that theoretically 26 per cent more work can be performed in utilizing a unit of heat in steam at 1,500 lb. than if utilized at 200 lb. It has also been shown that as high-pressure plants cannot be constructed to utilize the heat units available as efficiently as normal pressure plants, the theoretical figure of 26 per cent cannot be obtained in practice.

After making the necessary allowance for the difference in efficiency between the high- and normal-pressure turbine-generators, it may be taken that the original figure of 26 per cent will be reduced to 16.41 per cent if the following turbine and generator efficiencies are assumed:

| | Per Cent |
|---|---|
| Efficiency of high-pressure turbine | 74 |
| Efficiency of normal-pressure turbine | 80 |
| Efficiency of electrical generator, in each case | 95 |

The figure thus obtained, namely, 16.41 per cent is, however, only a measure of the increase in efficiency that may be realized in the utilization of steam by the adoption of the higher pressure. As the ultimate economy must be shown in terms of coal consumed, the boiler-plant efficiency will now be considered. On the assumption of 90 per cent boiler efficiency for normal pressure and 88 per cent for the high pressure the figure of 16.41 per cent is reduced to 13.8 per cent. The cost per kilowatt of a high-pressure plant will always be somewhat more than that of a normal-pressure plant of the same capacity, and it is also certain that the additional cost per kilowatt will increase in greater proportion the higher the pressure and the temperature adopted. From this it follows that in giving consideration to the installation of a high-pressure plant the question of the load factor at which the plant is to be run must receive careful thought,

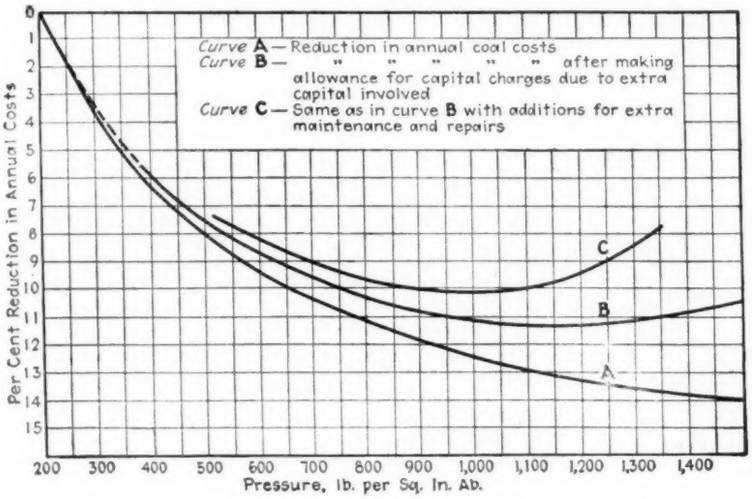

Curve A — Reduction in annual coal costs
Curve B — " " " " " after making allowance for capital charges due to extra capital involved
Curve C — Same as in curve B with additions for extra maintenance and repairs
Per Cent Reduction in Annual Costs
Pressure, lb. per Sq. In. Ab.

*Fig. 6—Percentage reduction in annual costs through increased pressure*

as the better the load factor the higher is the steam pressure that can be economically employed.

This fact has resulted in two different methods being adopted in which high-pressure steam is utilized in connection with large power plants. Under the first method the whole plant is laid out for high-pressure working, and under the second method high pressure (used in connection with an appropriate proportion of normal-pressure plant) is installed only of sufficient capacity to deal with the base-load of the station, the remaining load of poor load factor being dealt with by normal pressure, and, therefore, the cheaper plant. In the first case each turbine—usually a multi-cylinder machine—receives steam direct from high-pressure boilers. In the second but one or two turbines of comparatively small size are operated at high pressure, and the steam is exhausted from them into the normal-pressure steam range and utilized in any of the normal-pressure turbines coupled to that range.

It must be manifest that if the high-pressure plant proves to any great extent more costly than the normal-pressure plant, the cost per kilowatt of a station designed under the second method will be considerably less than of one designed under the first, and, therefore, a station containing high-pressure equipment solely is likely to prove justifiable only for meeting base-load requirements. The second method can, however, be applied with advantage to stations having comparatively low load factors, provided the amount of high-pressure equipment bears the proper relation to the capacity of the normal-pressure equipment.

### How the Coal Consumption Was Computed

On the basis of the curves in Fig. 2, showing the theoretical heat consumption at pressures of 200 lb. and upwards there was calculated the coal consumptions in tons per year, at various pressures for a plant of the capacity it was decided to install at Bradford and the normal pressure plant to be run in conjunction therewith, and the monetary values of the coal. From these a curve was produced (Curve *A* Fig. 6) indicating the percentage by which the total cost of coal per annum at the various pressures would be less than the cost at 200 lb. The curve, as might be expected, having regard to the curves in Fig. 3, showed an additional increase in the amount saved with each increase in pressure, but that the proportionate saving in respect of each increase in pressure became less the higher the pressure.

From curve *A* in Fig. 6, Curve *B* was plotted, indicating the net annual percentage saving that would result at various pressures after the capital charges on the additional cost of the plant due to increased steam pressure had been deducted from the savings in the cost of coal. From this curve it is clear that with an increase in pressure up to 800 lb. per sq.in. a substantial over-all saving is obtained, but the gain by increasing the pressure from 800 to 1,100 lb. is comparatively little, whereas from the point representing the pressure of 1,100 lb. the curve begins to rise, indicating that from that point the annual savings in coal are more than counterbalanced by the capital charges on the increased capital expenditure.

## Alessandro Volta

Volta died in Como a century ago, and the town on the beautiful Lake of Como is commemorating the centennial by an international exposition of electricity from May to October. The Italian government has co-operated in the memorial through the issuance of postage stamps and the contribution of liberal funds. America will participate in the centennial through representation by a committee formed by the Italy-America Society and the International Electrical Commission, which hopes to announce at Como a fellowship giving a year's study in the United States to an Italian electrical engineer.

Volta was interested in physics and chemistry as a boy. During his professorship in the Royal School at Como, and the quarter of a century during which he held the chair of physics at Pavia, he discovered the organic nature of marsh gas and devised many experiments in atmospheric electricity, such as igniting gases by electrical sparks in inclosed vessels.

### The "Voltaic Pile"

Of Volta's many discoveries the most dramatic was the "voltaic pile," an instrument used to decompose water into hydrogen and oxygen. Galvani's discovery of animal electricity led Volta to experiment with two different metals in contact, and by the use of his condensing electroscope he virtually proved his theory that the action of the current was due to the two metals.

Volta developed his electric pile of two dissimilar metals, such as zinc and copper, in contact, separated from a corresponding pair by paper or cloth soaked in weak brine. To this he added the "crown of cups," or first voltaic battery, in which strips of metal were placed in cups containing brine or weak acid. Scientists at first were divided over accepting his theories, but in the end his ideas triumphed.

One of the first countries to give recognition to Volta's discoveries was Great Britain, where in 1791 the Royal Society awarded him the Copley Medal. Davy, head of the Royal Institution of London, took an interest in Volta's work and had constructed a large pile consisting of several hundred disks. By this means he succeeded in isolating for the first time the metal sodium and potassium.

Napoleon, who in 1801 had summoned Volta to Paris to repeat for French savants his more important experiments, was indignant with the Academie des Sciences because the French had not made the discovery before Davy announced it. They replied that the English physicists succeeded because the funds had been furnished them for the construction of a huge voltaic pile. Napoleon provided funds for research and the French built a pile of their own. Napoleon went to inspect it shortly afterward, and to the astonishment of the custodians of the apparatus he seized the two terminals and placed them on his tongue before he could be prevented. He received a shock which rendered him speechless.

The English scientists made further use of Volta's discovery by raising public funds for the construction of an unusually large pile consisting of 2,000 pairs of plates. The first experiment made with this resulted in the production of electric arc light between two carbon poles in the laboratories of the Royal Institution.

Volta was made director of the philosophical faculty of Padua by the Emperor of Austria in 1815, but held the post only four years when he resigned to spend the remainder of his days in Como. Napoleon honored him with the title of count and senator of the kingdom of Lombardy, and had a medal struck for him. Commemorative of the discovery of the voltaic cell, a centennial exposition was held in Como in 1899 with unfortunate results. During its progress a number of valuable Volta relics and manuscripts were destroyed by fire.—*Progress of Science.*

## Meter Testing Apparatus

The modern electric meter department requires considerable equipment to maintain properly the various types of measuring devices under its care. Accurate standards must be available. Suitable test benches must be provided in the laboratory. Portable loading devices of various types and capacities are needed for use on customers' premises and in the generating stations and substations.

For loading devices on alternating current many utilities prefer to use low-voltage transformers as a source of supply for current. In the case of low voltage this may eliminate bulky rheostats. In the case of high voltage this method is very generally used, as transformers may be safely connected to the low-tension side of the potential transformer which supplies the meter to be tested. A number of interesting devices have been submitted in which the low-voltage transformers are combined with rotating test meters to give a one-piece portable test equipment.

When using such one-piece equipment, special care should be taken to calibrate the test meter in the laboratory, using its low-voltage transformer and controls. Stray fields, phase-angle displacement or possible wave-form distortion may be encountered and should be guarded against. If the test meter is calibrated throughout its usable range, using the low-voltage transformer, these troubles may be eliminated.—*Serial Report of the N.E.L.A. Meter Committee.*

# NEWS *of the* FIELD

## Universal Craftsmen Council Meet at Buffalo

With a registration of nearly seven hundred delegates and guests, the twenty-fifth annual international convention of the Universal Craftsmen Council of Engineers at Buffalo, Aug. 1 to 5, proved one of the most enjoyable in the history of the organization. For this much credit belongs to the local convention committee.

Following an informal reception at the Hotel Statler on Monday evening, the convention opened on Tuesday morning with P. D. Hutton, chairman of the local committee, welcoming the delegates to Buffalo. Addresses of welcome were also made by the Mayor and the Buffalo Chamber of Commerce. To these Grand Worthy Chief Louis J. Cudbird responded on behalf of the organization. Simultaneous meetings of the Grand Council and the ladies auxiliary were held each day at which reports were presented and business for the good of the order covered.

One hundred and twenty manufacturers of power-plant equipment had booths in the exhibit hall.

The social program included a bus ride to Niagara Falls, where lunch was served at the Fox Head Inn and an opportunity given all visitors to take in the attractions of the Falls; a boat ride to Fort Erie Beach; a theater party for the ladies and a stag party for the men; and finally, the banquet at the Hotel Statler on Thursday evening. The principal speakers on this occasion were Louis J. Cudbird, Grand Worthy Chief, and Dr. Silver Drew, an attorney of Buffalo. Mr. Cudbird summed up briefly the activities of the past year, discussed achievements of the association and expressed personal appreciation.

The officers for the coming year are: Grand Worthy Chief, W. Chas. Clark, Cleveland Heights, Ohio; Grand Assistant Chief, John R. Hass, Chicago; Grand Secretary, Thomas H. Jones, Cherrydale, Va.; Grand Treasurer, John L. O'Brien, Chicago; Past Grand Worthy Chief, Louis J. Cudbird, Toronto, Canada; Grand Warden, George A. Lambert, Brooklyn, N. Y.; Grand Guard, W. T. Wardell, Chicago; Grand Chaplain, M. W. Meekins, Baltimore. The Grand Trustees are: A. C. Elder of Los Angeles, Chas. F. Kuechle of Washington, D. C., and P. D. Hutton of Buffalo.

## Kansas Plant Adds Generators

Recent extension of the Hutchinson plant of the United Power & Light Corp., Kansas, included the installation of a 12,500-kw. turbo-generator with mechanical and electrical equipment. McClellan & Junkersfeld, engineering and construction, New York, handled the work.

## Gates Rubber Co. Building Own Power Plant

Ground for the construction of a power plant designed to furnish light, heat and power for the group of twenty-one factory buildings of the Gates Rubber Co., in Denver, was broken July 27.

A series of 600-hp. boilers operating on 400 lb. steam pressure will drive a group of 1,500-kw. condensing steam turbines. These boilers will be equipped with superheaters, economizers and electrical stokers. All coal and ashes will be handled automatically by electrically operated conveyors. The building itself will be of structural steel, concrete and brick, three stories high.

At the present time the Gates Rubber Co. uses 6 per cent of the total power and light consumed in the entire city and county of Denver. By operating with turbines under a high pressure, thus permitting the second and even third using of exhaust steam for process work in the factory, they are able to effect economy that will pay for this entire new power unit within approximately six years. The new plant will have a capacity of approximately 350,000,000 lb. of steam a year. Thirty-five per cent of this will be used for generating power and light, and 65 per cent for process work.

The new plant is being constructed under the direct supervision of Carl Ahlquist, chief engineer of the Gates Rubber Co.

*Universal Craftsmen Council of Engineers and their guests*

## Welding Society Plans Fall Papers and Exposition

Members of the American Welding Society will be attracted to the fall meeting of their organization at Detroit, Sept. 19-23, by a program of unusual interest planned to embrace eleven technical studies on welding application and a welding and cutting exposition.

Registration facilities will be provided the morning of the opening day at the exposition headquarters in Convention Hall for the men, and for the ladies at the Hotel Book-Cadillac. In the evening the American Bureau of Welding will hold a session at that hotel, following a meeting of the board of directors.

The first technical session will be called Tuesday morning for the presentation of five papers and reports. "Airplane Welding," by J. B. Johnson, chief of the Material Branch, War Department, Air Corps, McCook Field, will be followed by consideration of "Welding on the Long Distance Aircraft," by the Atlantic Aircraft Corp. In the afternoon report will be made on the San Francisco Section's investigations on the study of welds subjected to high temperatures. Heat treatment by the oxyacetylene flame will be the subject of a talk by E. E. Thum, associate editor of *Iron Age*. Then G. R. Brophy, research laboratory of the General Electric Co., will offer a metallurgical study of welds.

"Car Welding," by Victor Willoughby, general mechanical engineer, American Car & Foundry Co., and "Automobile Welding," by W. C. Happ, chief engineer, department of methods and standards, Studebaker Corp., will constitute the technical business Wednesday morning, Sept. 21. On Thursday, "Production Welding of Water Heaters," by H. J. Grow, Air Reduction Sales Co.; welding in the plant of the Combustion Engineering Corp., by C. S. Reed, vice-president and general manager of the corporation; welding of structural steel, by Joseph Matte, Jr., Albert Kahn, Inc., and welding in the design of steel plate work, by L. J. Sforzini, engineering and maintenance department, Eastman Kodak Co., will complete the technical studies.

The welding and cutting exposition will be held in Convention Hall in cooperation with the National Steel and Machine Tool Exposition. More than 10,000 sq.ft. of space has been allotted for the welding exhibits to be grouped together for convenient inspection.

Automobile trips, theater parties, musicales and dances will constitute ample entertainment for the ladies. The annual fall dinner of the Society will be held Sept. 22 in the large ballroom of the Hotel Book-Cadillac.

## Long Island, N. Y., Plants Buy Diesel Engines

Three towns on Long Island, N. Y., have recently purchased Diesel engines for the increase of power service. The Rockville Center municipal power plant has purchased two 1,200-hp. and one 800 hp. Diesel engines from the McIntosh & Seymour Corp., arranged for direct connection to generators. These will replace the present steam units as well as eliminate the purchased power now used.

The Freeport municipal light plant, which contains four Diesels, has placed an order with the Busch-Sulzer Diesel Engine Co. for another 1,150-hp. Diesel generator set. The addition will make the total capacity 4,200 hp., and this the largest municipal plant in the East. Greenport, also has bought a 400-hp. Busch-Sulzer Diesel for its municipal plant.

## Aeronautical Engineer Wins Rudolph Diesel Award

The Rudolph Diesel Award will be made to W. F. Joachim, mechanical engineer, Langley Memorial Aeronautical Laboratory, who has been selected to receive the award for 1927. A suitable certificate and a cash prize of $100 are to be given for his paper entitled "Oil Spray Investigations of the National Advisory Committee for Aeronautics," which was presented at the Oil Power Week meeting, April 21-23, at Pennsylvania State College, State College, Pa.

The Committee of Award consisted of F. Thilenius, division superintendent, Prairie Pipe Line Co.; F. G. Hechler, professor of engineering research, Pennsylvania State College, and R. Miller, assistant chief engineer, oil engine department, Ingersoll-Rand Co.

The award, established in honor of the man whose name is so closely connected with the modern oil engine, is given annually in connection with the activities of Oil Power Week, for the best written contribution toward the advancement of oil engines delivered at any of the meetings held throughout the country. In this year's celebration of Oil Power Week, 106 meetings of national technical societies were held.

The national committee in charge of Oil Power Week consisted of R. P. Anderson, D. L. Fagnan, J. D. Jones, D. F. Killeffer, L. H. Morrison, *Power;* L. H. Roller, and E. J. Kates, chairman.

## Texas Plant Sold

The Central Light & Power Co., Texas, purchased the Falfurrias Light & Power Co. for a consideration of $275,000. The properties involved in this sale were waterworks, electric light machinery and ice factory.

*Attending the twenty-fifth annual convention*

## Boiler Production Increases During July

Production in the boiler manufacturing industry appears to be holding up better during the present summer than during the same period of last year. The drastic drop in production which was recorded during July of last year and in June of 1925, was not repeated during the present year. Instead of a continued curtailment in production as experienced last year a distinct upward turn in production operations were recorded in July of this year.

Returns received by *Power* on the monthly consumption of electrical energy by a large number of boiler manufacturing companies indicate that the productive activity of the industry during July was about 4.8 per cent over June, and 15.5 per cent over July of last year, after corrections are made for the number of working days in the months. The actual production of boilers during July was also slightly greater than that during June. The July operations, however, were not over those of June in the case of many of the reporting manufacturing companies, one quarter of the companies reporting July productive activities as under those of June.

July appears to have witnessed the end of the almost continual recession in production which has been reported for each month since the beginning of the year. Only March records a slightly increased boiler production, but this higher monthly production was due entirely to the fact that March had three more working days than February and one more than April. There is little doubt but that August will witness a continuation of the upward trend starting in July, thereby making June the low month of the year. Notwithstanding this long and continued recession in operations since the opening of the year, the returns indicate that the actual production of boilers during the seven months has been less than 1 per cent under the production reported for the same period of last year.

Much has been written relative to industry as a whole registering a decline in earnings during the first half of the year. A survey by such an authority as the Standard Statistics Company indicates that fully 92 per cent of the dividen-paying industrial companies have more than covered their regular common dividend requirements during the first half of the year, and that 37 per cent of these dividend-payers covered their requirements more than twice over in the same period. The general expectation as the summer closes seems to be for at least slightly increased operations in general industry as the fall months open, increasing in volume as the year draws to a close.

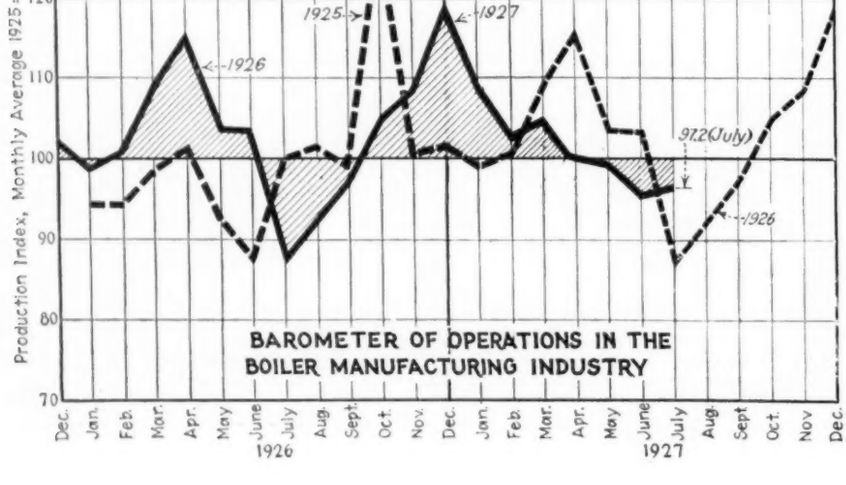
## Electricity Output to June Up 9½%—Fuel Oils Off

The monthly report of the production of electricity by public utility power plants for May, issued by the Geological Survey, shows a total for the first five months of the year amounting to 32.4 billion kw.-hr. or about 9½ per cent more than the output for the same period of 1926.

An estimate based on the output so far this year and on comparable figures for 1926 indicates that the total output for 1927 will be in the neighborhood of 80 billion kw.-hr. The total for 1926 was 73:8 billion kilowatt hours.

The effect of the increasing hours of daylight and the rising temperature from the first to the middle of the year on the demand for electricity for light and heat is shown in the decrease in the average daily production of electricity that occurs during this period each year. This year the decrease in the average daily output from January to May was about 3 per cent; in 1926 the decrease was about 5 per cent; in 1926, 6 per cent. The lessening of the decrease in 1927 may be due, in part, to the increasing load for electrical refrigeration, according to the survey.

It is pointed out by the survey that, notwithstanding the record-breaking output of petroleum this year, the consumption of fuel oils by public utility power plants has decreased each month, and the consumption in May was less than in any other months since the Geological Survey began to compile monthly power reports in 1919.




## Leases to Alabama Power Co. are Renewed for Year

Renewal of the lease to the Alabama Power Co., for a period of one year, from Aug. 1, of the 1,000 kilowatt substation, and other facilities and equipment connected therewith, located at Waco Quarry, near Russellville, Ala., has been affirmed. This property was originally leased to the Alabama Power Co., under date of July 16, 1923, for one year, from August 1, 1923, the said lease having been renewed in July, 1924, July, 1925, and July, 1926, each time for a period of one year. The new lease is essentially the same as the original lease and the subsequent renewals thereof.

The Secretary of War has ratified also the renewal of the lease executed by the Commanding Officer of the United States Nitrate Plant No. 2, Military Reservation, Muscle Shoals, Ala., to the Alabama Power Co. for one year, from June 1, 1927, of the government owned electric railway and its appurtenances at the plant mentioned above.

## 25,000 Kw. More for Dallas

A 25,000-kw. turbine, which will raise the present generating capacity to 57,500 kw., a capacity which will cover present requirements and provide for future growth of Dallas, Texas, was put into operation by the Dallas Power & Light Co. recently.

## *Personal Mention*

JOHN DILLON has entered his 50th year of service with the Lawrence Gas & Electric Co., Mass. Close to his record as the senior employee of that organization is that of JOHN LOFTUS with his 46 years of duty fulfilled. SIMON MCHUGH and JAMES MCNAMARA have each 40 years to their credit.

L. V. SUTTON, for the last two years assistant general manager of the Arkansas Power & Light Co. at Little Rock, Arkansas, has been appointed the successor of C. P. Couch, vice-president and general manager of the Mississippi Power Co. at Jackson, Miss. Mr. Couch goes to Dallas, Texas, to become general manager of a utility company of that city.

J. R. SPROAT has recently been appointed superintendent of Wm. B. Scaife & Sons Co., Pittsburgh, known principally as manufacturers of steel tanks, range boilers, and water purifying apparatus.

## Business Notes

THE BLAW-KNOX CO., with general offices at Pittsburgh, Pa., and with plants at Blawnox, Pa., and Baltimore, has purchased the Milliken Brothers Manufacturing Co., of New York. The consolidation of the two companies will become effective on Sept. 1.

THE FOOS ENGINE CO., Springfield, Ohio, has opened a branch office at Tulsa, Okla., to maintain there a depot for a complete stock of parts, service, engine repairs and order department for new Foos engines for power requirements. The address of this branch is 209 East Archer Street.

THE EDWARD VALVE & MANUFACTURING CO. announces a change in the organization of its Cleveland representatives, who have reincorporated under the name TOMLINSON-MACLACHLAN, Inc. New quarters providing improved facilities have been established at 1601 St. Clair Ave., Cleveland.

THE CRANDALL PACKING CO., Palmyra, N. Y., announces that O. W. Wagner has been appointed director of sales. He will be located at the New York office of the company at 109 Liberty St., and will have direct charge of the sales activities of the company through its eleven branch offices.

THE CHAIN BELT CO., Milwaukee, has transferred Charles G. Olson, formerly of the main office, to the Detroit office. Mr. Olson was connected with the sales department for several years before his transfer. He will look after the Rex chain and engineering business of the company in Detroit territory with headquarters at the company's office at 8855 Woodward Avenue.

## Trade Catalogs

PACKING—The Crandall Packing Co. has just issued a new catalog. It is known as Catalog No. 10 and carries complete details in its 108 pages on the complete line of packings manufactured by this company.

PORTABLE AIR COMPRESSORS — Bulletin No. 83-F of the Sullivan Machinery Co., Chicago, Ill., describes gasoline-engine and electric-motor driven portable air compressors. The smaller units are of the two-cylinder vertical type and the larger are four-cylinder 90-deg. units of the balanced-V compressor type.

## Coming Conventions

**American Institute of Electrical Engineers.** F. L. Hutchinson, secretary, 33 West 39th St., New York City. Pacific Coast convention at Del Monte, Calif., Sept. 13-16.

**American Refractories Institute** will hold its fall meeting Thursday, Sept. 15, at the Clifton Hotel, Niagara Falls, Canada.

**American Water Works Association.** California Section, at San Jose, Oct. 5-8; Paul E. Magerstadt, sec., East Bay Water Co., Oakland; Central States Section will hold annual meeting at Akron, Ohio, Sept. 15-16; E. E. Bankson, sec., Union Bank Building, Pittsburgh. North Carolina Section, at Durham, Nov. 7-9; H. G. Baity, sec., Univ. North Carolina, Chapel Hill; Southwest Waterworks Association will meet at Hot Springs, Ark., Oct. 10; Lewis A. Quigley, sec., superintendent of City Waterworks, Fort Worth, Tex.

**American Society of Mechanical Engineers.** Calvin W. Rice, secretary, 33 West 39th St., New York City. Seattle, Wash. Section, Aug. 29-31.

**American Welding Society,** fall meeting at Book Cadillac Hotel, Detroit, Sept. 19-23.

**Association of Edison Illuminating Co's,** convention at Colorado Springs, Col.; Sept. 26-30.

**Canadian Steel and Power Show** and technical sessions will be held at the University of Toronto Arena, Toronto, Ont., Aug. 31, Sept. 1 and 2; Campbell Bradshaw, general chairman of exposition committees, 153 University Ave., Toronto, Ont.

**Empire State Gas and Electric Association,** meeting at Lake Placid, N. Y.; Oct. 6-7.

**National Association of Practical Refrigerating Engineers.** Eighteenth annual convention and educational exhibition in Civic Convention Hall and headquarters Hotel Whitcomb, San Francisco, Calif., Nov. 29 to Dec. 2. H. Fox, 5707 W. Lake St., Chicago, Ill.

**National Association of Stationary Engineers**—Annual convention at Ambassador Hotel, Los Angeles, Calif., Aug. 22-27, in connection with the Pacific Coast Power and Mechanical Exhibit.

**National Fuels Meeting,** under the auspices of the Fuels Division of the American Society of Mechanical Engineers, will be held Oct. 10-13 at St. Louis, Mo.

STARTING RHEOSTATS—Bulletin GEA-59 of the General Electric Co. describes line CR1003 inclosed heavy-duty starting rheostats for direct-current motors.

SPEED CONTROLLER—Bulletin GEA-360A of the General Electric Co. describes CR7761-F1 remote-indicating speed controller for slip-ring induction motors.

PORTABLE HOISTS—Bulletin No. 76-F, third edition, of the Sullivan Machinery Co., Chicago, Ill., describes the Sullivan "Turbinair" portable hoists, operated by a simple air turbine. The operation of the turbine is explained and the applications of the hoists to a variety of uses is shown.

DIESEL ENGINES—The Worthington Pump & Machinery Corp., 115 Broadway, New York City, describes and treats of Worthington double-acting two-stroke-cycle Diesel engines in Bulletin No. S—173. Crosshead design, fuel valves, spray air compressor, piston-rod packing, and piston cooling are briefly discussed. The whole is well illustrated by 25 sectional views and photos of installations.

COMPRESSED-AIR SPADERS — Bulletin No. 81-N of the Sullivan Machinery Co., Chicago, Ill., explains the uses and advantages of the class "DH-361" clay spader. The tool consists of a light air hammer equipped with long or short steel blades, and it is claimed it will save from 40 to 60 per cent of the labor cost of excavation on a job.

## Fuel Prices

### COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

| **Bituminous** | Market | Aug. 3 |
|---|---|---|
| Net Tons | Quoting | 1927 |
| Pool 1 | New York | $2.50@$2.75 |
| Smokeless | Boston | 1.63 |
| Clearfield | Boston | 1.60@ 1.90 |
| Somerset | Boston | 1.70@ 2.00 |
| Kanawha | Columbus | 1.25@ 1.50 |
| Hocking | Columbus | 1.75@ 1.90 |
| Pittsburgh | Pittsburgh | 1.90@ 2.15 |
| Pittsburgh gas slack | Pittsburgh | 1.30@ 1.45 |
| Franklin, Ill | Chicago | |
| Central, Ill | Chicago | |
| Ind. 4th Vein | Chicago | |
| West Ky | Louisville | 2.25@ 2.50 |
| S. E. Ky | Louisville | 1.50@ 1.75 |
| Big Seam | Birmingham | 1.50@ 2.15 |
| **Anthracite** | | |
| Gross Tons | | |
| Buckwheat No. 1 | New York | 2.50@ 3.25 |
| Buckwheat No. 1 | Philadelphia | 2.50@ 3.00 |
| Birdseye | New York | 1.40@ 1.65 |

### FUEL OIL

**New York**—Aug. 11, light oil, tank-car lots; 28@34 deg. Baumé, 5c. per gal.; 36@40 deg., 5¼c. per gal. f.o.b. Bayonne, N. J.

**St. Louis**—Aug. 3, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.65 per bbl.; 26@28 deg., $1.70 per bbl.; 28@30 deg., $1.75 per bbl.; 30@32 deg., $1.80 per bbl.; 32@36 deg., gas oil, 4.6c. per gal.; 38@40 deg., 5.3c. per gal.

**Pittsburgh**—Aug. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 4¾c. per gal.; 36@40 deg., fuel oil, 5c. per gal.

**Philadelphia**—Aug. 3, 26@30 deg., $2.05@$2.11 per bbl.; 13@19 deg., $1.68@$1.74 per bbl.

**Cincinnati** — Aug. 9, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¼c. per gal.; 26@30 deg., 5½c. per gal.; 30@32 deg., 5¾c. per gal.

**Chicago**—Aug. 6, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., 95c. per bbl; 26@30 deg., 97½@$1.00; 30@32 deg., $1.10.

**Boston**—Aug. 8, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal.; 28@32 deg., 5.65c. per gal.

**Dallas**—Aug. 6, f.o.b. local refinery, 26@30 deg., $1.45 per bbl.

# NEW PLANT CONSTRUCTION

**Calif., Los Angeles**—Pacific Southwest Trust & Savings Bank, 565 S. Spring St., is having plans prepared for the construction of a 12 story bank and office building including steam heating system, elevators, etc. at Hollywood Blvd. and Highland Ave. Estimated cost $500,000. Meyer & Holler, Wright & Callendar Bldg., are architects.

**Calif., San Francisco**—Huckins Hotel System, c/o Weeks & Day, Financial Center Bldg., awarded contract for the construction of a 22 story hotel at Powell and Sutter Sts. to Lingren & Swinerton, 225 Bush St. Estimated cost $2,000,000.

**Calif., San Francisco**—Pacific Gas & Electric Co., 245 Market St., will build an electric sub-station at 9th Ave. and Judah St. by day labor. Estimated cost $15,000.

**Conn., Bridgeport**—City National Bank, C. E. Hough, Pres., awarded contract for the construction of a 12 story bank and office building at Main and John Sts. to Dwight P. Robinson Co. Inc., 125 East 46th St., New York, N. Y. Estimated cost $1,200,000.

**Conn., Bridgeport**—United Hotel Corp., 25 West 45th St., New York, N. Y., awarded contract for the construction of a 12 story hotel on Fairfield Ave. here to Turner Construction Co., 420 Lexington Ave., New York, N. Y. Estimated cost $1,500,000.

**Ill., Chicago**—J. Horwitz, 10 South La Salle St., will soon receive bids for the construction of a theatre including cooling plant at 119th St. and Egleston Ave. Estimated cost $600,000. G. E. McClellan, 7441 Cottage Grove Ave., is architect.

**Ill., Chicago**—W. L. Wallen & Sons, 6712 North Clark St., awarded contract for masonry, etc. for a 17 story addition to hotel at 405 Fullerton Ave. Jonck & Ehmann, 140 South Dearborn St., are architects.

**Ill., Chicago**—H. Zisook, 1259 East 55th St., will receive bids about Aug. 15 for the construction of an 8 story apartment building including elevators, etc. at 5719-5721 Kenwood Ave. Estimated cost $500,000. T. R. Bishop & Son, 35 South Dearborn St., are architects.

**Ill., Riverside**—Chicago Zoological Society, 35 North Dearborn St., Chicago, awarded contract for the construction of a group of buildings including power house, etc. here, to H. F. Friestedt & Co., 135 North Michigan Ave., Chicago. Estimated cost $300,000.

**Ia., Sheldon**—Western States Public Utilities Co., 521 Terminal Trust Bldg., Lincoln, Neb. plans the construction of a power plant and distribution system, here. Estimated cost $250,000. Private plans. City votes on franchise Aug. 25.

**Mass., Somerville** (Boston P.O.)—City will soon award contract for the construction of a boiler house and heating plant for Highland Ave. School.

**Mass., Westfield**—Water Comrs., Springfield, plans the construction of a power plant and dam on Cobble Mountains, here. Estimated cost $750,000. Private plans.

**Mo., Osceola**—Ozark Utilities Co., Pleasant Hill, awarded contract for the construction of a power house, 2,000 hp. capacity and dam, 400 ft. long to G. P. Reintjes Co., 2517 Jefferson St., Kansas City, Mo. Estimated cost $250,000.

**Neb., Mitchell**—Bureau of Reclamation, Dept. of Interior, Washington, D. C., awarded contract for the construction of second unit of Guernsey power plant, North Platte project, here, to Utah Construction Co., Ogden, Utah. Estimated cost $20,860.

**Neb., Union**—City plans an election Aug. 18 to vote $18,500 bonds for waterworks improvements including well, pump house, 50,000 gal. tank on tower, etc. Henningson Engineering Co., National Bank Bldg., Omaha, is engineer.

**N. J., Hackensack**—Prospect Ave. Realty Co. Inc., H. H. Harris, Pres., 15 Exchange Pl., Jersey City, had plans prepared for the construction of a 5 story apartment building including steam heating and refrigeration systems, boilers, elevators, etc. at Prospect and Passaic Ave. here. Estimated cost $500,000. Flagg & Stades, 665 Newark Ave., Jersey City, are architects.

**N. J., Newark**—Newark Auditorium Inc., E. I. Clark, 671 Broad St., had plans prepared for the construction of a 20 story hotel and theatre building including steam heating refrigeration and ventilation systems, boilers, elevators, swimming pool, etc. at Washington and James Sts. Estimated cost $6,000,000. T. W. Lamb, 644 8th Ave., New York, N. Y., is architect. H. H. Marshall, 37 West 43rd St., New York, N. Y., is engineer.

**N. J., Scotch Plains**—Bd. of Chosen Freeholders of Union County, Court House, Elizabeth, N. J., will soon receive new bids for the construction of a hospital, power house, etc. here. Estimated cost $200,000. Oakley & Son, 1259 Clinton Pl., Elizabeth, N. J. Former bids rejected.

**N. Y., Corning**—Bd. of Public Works, W. O. Drake, Supt., will receive bids until Aug. 22 for the construction of a pumping station. H. B. Cleveland, 225 Broadway, New York, N. Y., is consulting engineer.

**N. Y., Corning**—T. M. Kirkpatrick, 220 South 16th St., Philadelphia, Pa., Archt., will receive bids until Aug. 22 for the construction of a 5 story hotel including elevators, etc. here. for Corning Hotel Corp.

**N. Y., New York**—A. E. Lefcourt, 1357 Broadway, will build a 31 story office building including ventilation system, elevators, etc. at Broad and Beaver Sts. by day labor. Estimated cost $5,000,000. Buchman & Kahn, 49 West 45th St., are architects.

**N. Y., New York**—New York Athletic Club, 58 West 59th St., awarded contract for the construction of a 20 story club building at 7th Ave. from 58th to 59th Sts. to C. T. Wills, Inc., 286 5th Ave. Estimated cost $4,800,000.

**N. Y., Raybrook**—Division of Standards & Purchase, Executive Dept., Capitol, Albany, will receive bids until Sept. 1, for the construction of a power house, etc. for New York State Hospital for the treatment of Incipient Pulmonary Tuberculosis here.

**N. Y., Rochester**—Lake Ontario Water Co., 16 Main St. W., awarded contract for waterworks improvements including pumping station, etc. to J. G. White Engineering Corp., 43 Exchange Pl., New York, N. Y. Estimated cost $1,000,000.

**Okla., Weleetka**—City is having plans prepared for the construction of a 12 ton addition to ice plant. Estimated cost $30,000. Private plans.

**Pa., Philadelphia**—Charles J. McIlvaine, c/o McIlvaine & Roberts, Otis Bldg., Archts., will receive bids until Aug. 17 for the construction of a 20 story apartment building including steam heating system, boilers, elevators, etc. at 2031 Locust St. Estimated cost $1,000,000.

**R. I., Providence**—Flynn's Towel Supply Co., 9 Doyle Ave., will build a boiler house, etc. at Doyle Ave. and Scott St. by day labor. W. G. Richards, 211 Westminster St., is architect.

**Tenn., Nashville**—C. B. Ragland Wholesale Grocery Co., Second and Mulloy Sts., awarded contract for the construction of a warehouse including refrigeration and cold storage plants, etc. on Duncan St. to Mangaums-Bell Construction Co., Murfreesboro. Estimated cost $65,000.

**Tex., Beaumont**—Gulf State Utilities Co., c/o J. G. Holtzclaw, V. Pres., will build a 30,000 kw. additional unit to power plant on the Neches River by day labor to triple the present capacity. Estimated cost $4,000,000. Private plans.

**Tex., Belton**—Bell Co., Farm Bureau Cotton Assn., c/o M. H. Casey, is receiving bids for the construction of a cotton gin, 5 stand, 80 saw capacity. Estimated cost $40,000. Electrically operated or crude oil power unit will be required.

**Tex., Brownsville** — Cameron County Water Control Dist. No. 7 El Jardin, voted $175,000 bonds for extensions and improvements to irrigation system including the installation of electrically driven machinery for pumping plants, etc. here. W. O. Washington, is county engineer.

**Tex., Jacksonville**—F. E. Churchill, is having preliminary plans prepared for the construction of an electric light plant. Estimated cost $45,000.

**Tex., Laredo**—Central Power & Light Co., S. M. Udden, Frost Bldg., San Antonio, awarded contract for waterworks improvements including filtration plant and pumping station, etc. here to McKenzie Construction Co., Travis Bldg., San Antonio. Estimated cost $134,574.

**Tex., Marathon**—Borderland Utilities Co., Fort Stockton, plans the construction of a 15 ton addition to ice plant, here. Estimated cost $25,000.

**Tex., Raymondville**—Delta Cities Co., c/o W. A. Harding, Pres., awarded contract for the development of 21,300 acres of land for town sites of Santa Margarita, Santa Monica, Lasara Hill and Rolle, including pumping equipment for wells for water needed in the irrigation of the tracts to Rayburn Construction Co., c/o owner.

**Tex., Rio Hondo**—City plans an election Aug. 30th to vote $15,000 bonds for waterworks improvements including pumping equipment, mains, etc.

**Tex., Willis**—Planters Gin Co., has acquired a site and plans the construction of a cotton gin plant, 8 stand, 80 saw capacity. Estimated cost $40,000. Private plans. Electrically operated or crude oil burning engines will be required.

**Ont., Toronto**—Star Publishing Co., 18 King St. W., plans the construction of a 10 or 12 story office building including steam heating system, elevators, etc. Estimated cost $800,000. Chapman & Oxley, Northern Ontario Bldg., are architects.

## Equipment Wanted

**Air Compressors**—Empire Pipe Line Co., Mooreland, Okla., will be in the market for three 1,000 hp. Diesel engine driven air compressors for proposed natural gas compressor stations Estimated cost $75,000.

**Engine and Generator** — City of Boise City, Okla., plans to purchase a 200 hp. Diesel engine, and generator for proposed ice plant. Estimated cost $75,000.

**Engine and Pump**—Prairie Pipe Line Co., Independence, Kan., plans the installation of a 660 hp. Diesel engine and pump for Panova pumping station at Shawnee, Okla. Estimated cost $40,000.

**Engines, Generators, Etc.**—Western States Public Utilities Co., 521 Terminal Bldg., Lincoln, Neb., will be in the market for two 500 hp. Diesel oil engines, generators, etc. for proposed power plant at Sheldon, Ia.

**Generator Sets**—Institutions Dept., W. S. Kinney, Comr., City Hall, Boston, Mass., will receive bids until Aug. 17 for new engine generator sets for power house at Long Island Hospital, Boston Harbor, Mass. Estimated cost $50,000.

**Generating Unit**—Borderland Utility Co., Fort Stockton, Tex., is in the market for a 120 hp. generating unit.

**Hoists**—Page L'Hoe Ltd., Carondelet Bldg. New Orleans, La., is in the market for electrically operated hoists for proposed wharf, 1,600 ft. long at Point Isabel, Tex.

**Motor**—R. Dupras, 4389 Christopher Columba St. Montreal, Que., is in the market for a 15 hp. electric motor.

**Pump and Motor**—City of Ryan, Okla., will be in the market for a triplex pump and motor for proposed waterworks improvements. Estimated cost $15,000.

**Pump and Motor**—B. Gilman, 360 Norfolk St., Dorchester, Mass., is in the market for a rotary pump with 2 or 3 hp., 3 ph. 220 v. motor.

**Pumping Equipment**—City of Cabool, Mo., will be in the market for pumping equipment, etc. for proposed waterworks improvements. Estimated cost $39,000.

**Pumping Units**—Dept. of Public Works, J. W. Reid, Comr., Detroit, Mich., will receive bids until Sept. 28 for four vertical motor driven pumping units for Connors Creek storm water pumping station.

**Pumps**—City of Allentown, Pa., will receive bids until Sept. 6 for furnishing and installing centrifugal pumps for proposed sewage treatment plant.

**Pumps, Etc.**—Borderland Utility Co., Alpine, Tex., will be in the market for pumps, etc. for proposed waterworks system. Estimated cost $40,000.

**Pumps, and Motors, Etc.**—W. A. Tibbs, clk., Macon, Mo., will receive bids until Aug. 25 for two 700 g.p.m. centrifugal pumps and motors, etc. for proposed waterworks improvements.